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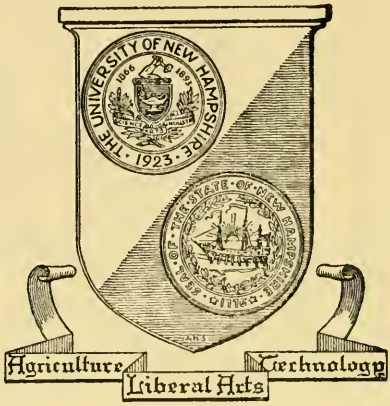

The University
of
New Hampshire

BULLETIN 345 DECEMBER 1942

Agricultural Research in New Hampshire

Annual Report of the Director of the
Agricultural Experiment Station
for the Period Ending
June 30, 1942

DURHAM, NEW HAMPSHIRE

Foreword

The descriptions of experimental projects to be found on the following pages are excerpts or summaries of the work in progress or completed to date. Space prevents their being comprehensive.

Any person interested in results or procedures concerning one or more lines of research should feel free to write the Director or any person listed on the project for additional details or for publications. Suggestions for improving our research work or for instigating new investigations that might solve important farm problems are always welcome.

M. GALE EASTMAN, Director
Agricultural Experiment Station

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AGRICULTURAL EXPERIMENT STATION STAFF

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Arval Erikson, M.S., Assistant to Director*
Harold C. Grinnell, Ph.D., Assistant to Director
John C. Sim, M.A., Editor
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Todd O. Smith, M.S., Associate Chemist
Stanley R. Shimer, M.S., Assistant Chemist
Gordon P. Percival, M.S., Assistant Chemist
Henry A. Davis, M.S., Assistant in Agricultural and Biological Chemistry

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Harry C. Woodworth, M.S., Agricultural Economist
Max F. Abell, Ph.D., Assistant Agricultural Economist
L. A. Dougherty, B.S., Assistant Economist in Marketing
Harold C. Grinnell, Ph.D., Assistant Agricultural Economist
Arval Erikson, M.S., Assistant Economist in Marketing*
Dean Hosken, A.B., Research Assistant in Agricultural Economics

AGRONOMY AND AGRICULTURAL ENGINEERING

Ford S. Prince, B.S., Agronomist
Paul T. Blood, M.S., Assistant Agronomist
Leroy J. Higgins, B.S., Assistant Agronomist
C. L. W. Swanson, Ph.D., Soil Survey Assistant
Walter H. Lyford, Jr., M.S., Cooperative Field Agent in Soil Conservation Service
Bessie G. Sanborn, Seed Analyst

ANIMAL HUSBANDRY

Ernest G. Ritzman, M.S., Research Professor in Animal Husbandry
Nicholas F. Colovos, M.S., Assistant in Animal Husbandry
Albert D. Littlehale, Shepherd
Helen H. Latimer, Gas Analyst

BOTANY AND BACTERIOLOGY

Albion R. Hodgdon, Ph.D., Plant Taxonomist
Stuart Dunn, Ph.D., Assistant Botanist
Lawrence W. Slanetz, Ph.D., Bacteriologist
Mathias C. Richards, Ph.D., Plant Pathologist
Arthur F. Howe, B.S., Graduate Assistant in Bacteriology
Raymond W. Barratt, B.S., Graduate Assistant in Botany
Bessie G. Sanborn, Laboratory Assistant in Bacteriology

DAIRY

Kenneth S. Morrow, M.S., Dairy Husbandman
Herbert C. Moore, M.S., Assistant Dairy Husbandman
Harry A. Keener, Ph.D., Research Assistant in Dairy Husbandry

ENTOMOLOGY

Walter C. O'Kane, M.A., D.Sc., Entomologist
James G. Conklin, Ph.D., Assistant Entomologist
Leon C. Glover, Ph.D., Research Assistant in Entomology
Anthony Standen, B.A., M.S., Research Chemical Assistant

FORESTRY

Clark L. Stevens, Ph.D., M.F., Forester
Lewis C. Swain, M.F., Assistant Forester
William A. Johnson, B.S., Assistant in Forestry

HOME ECONOMICS

Wilma D. Brewer, M.S., Assistant Home Economist
Alice M. King, B.S., Field Assistant in Nutrition Research
Tatiana Levcowich, M.S., Research Assistant in Home Economics

HORTICULTURE

Albert F. Yeager, Ph.D., Horticulturist
L. Phelps Latimer, Ph.D., Assistant Horticulturist
Henry S. Clapp, M.S., Assistant Horticulturist
Winfred D. Holley, M.S., Assistant Horticulturist
William W. Smith, Ph.D., Research Assistant in Horticulture
James Macfarlane, Assistant in Greenhouse
William P. Haubrich, B.S., Assistant in Horticulture

POULTRY

T. Burr Charles, M.S., Poultry Husbandman
Ernest F. Waller, D.V.M., Poultry Pathologist
Fred E. Allen, D.V.M., Assistant Poultry Pathologist
Alan C. Corbett, D.V.M., Assistant Poultry Pathologist
Carl W. Hess, M.S., Research Assistant and R. O. P. Supervisor
Richard Ford, Assistant Technician in Poultry Husbandry
Harriet L. Goodwin, B.S., Laboratory Technician
Madeline Papachristos, B.S., Assistant Technician in Poultry Husbandry

ASSISTANTS TO THE STAFF

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Elizabeth E. McFadden, Secretary to Dean and Director
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Sara M. Sanborn, Stenographer
Laverna E. Murphy, Stenographer
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Eileen McLaughlin, Stenographer
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Edith M. Smith, Stenographer
Marion A. Holbrook, Stenographer
Barbara E. Fuller, Stenographer

*On leave

Agricultural Research in New Hampshire

THIS REPORT covers eighteen months of time from January 1941 to June 1942. The longer time provides for a transition from the calendar year to a fiscal year as a more desirable unit of time to be included in annual reports of the Agricultural Experiment Station. This is not merely a change of convenience but one of economy in time and effort, avoiding considerable duplication in minor or departmental reports for other purposes and making these narrative annual reports conclusive with financial reports, both state and federal, which have to be submitted every year as of June 30.

FOOD FOR FREEDOM

With the advent of war the farmer becomes at once the most indispensable and the most harassed of war workers. Even as these lines are being written and Hitler is staging by far the most terrible battle the world has ever experienced, throwing in reserves of manpower he can ill afford to sacrifice to win the Caucasus, he is doubtless haunted by the growing dread of a hunger which oil cannot appease. The scorched earth policy of his enemies and the shortage of dependable workers to carry on with the good earth in cooperation with nature may yet destroy the morale of his supersoldiers and his misguided countrymen. He may yet learn that Nature favors those who do not fight!

American farmers not yet recovered from the maladjustments following the last war are suddenly urged to right-about-face and produce more. A few years ago science and the American farmer's efficiency were being blamed by many for mounting surpluses and failure to adjust production to consumption. Now, as the result of army medical examinations, we are aware of the results of much inadequate nutrition; at the same time, the sudden need for producing, preserving, and transporting the health-giving products of the soil for our Allies as well as for our own forces in foreign countries becomes apparent. Fortunate, indeed, are we that agricultural research and agricultural education were not unduly stifled or curtailed in the 30's as advocated by some. Research governing plant and animal production, freezing, drying, and other newer phases of food preservation, insect and disease control, fertilizer economy, vitamin needs and sources—all the results and techniques of investigation are sorely needed today and must be intensified in anticipation of an even greater need tomorrow.

THE ROLE OF THE EXPERIMENT STATION

State agricultural experiment stations are sensitive to these needs. Starting with international wars and rumors of wars and definitely accelerating with the impetus of the Pearl Harbor episode and its resultant United States declaration, our own experiment station plans have been

multiplied and complicated with the passing months. Our first objective was to revise and evaluate all research work under way in the light of the new goals necessitated by lend-lease and war activities. Toward this end, each person in charge of any research work was asked to review all activities financed under his direction and, seeking the advice and judgment of all his colleagues, to attempt to determine the fitness and timeliness of each and every activity. Influenced somewhat by the Director's participation in a committee of the Northeastern Station representatives charged with this problem, the thinking of our personnel was directed along these lines:

1. Does the project have a definite war value?
2. Does it have a definite value in the aftermath of the war?
3. Regardless of its scientific value, can it be held in abeyance for the duration?
4. Can it be discontinued indefinitely to release funds for new war projects?
5. Are there new projects that should be inaugurated?

Various problems were discussed with individuals and groups, and written reports were required to be filed in the Director's office. As a result, several projects have been suspended or closed out. Nearly all others have been revised to conform to the war needs as well as such needs can be interpreted at the moment. For the duration, all projects tend to be written on a temporary basis to be reappraised periodically. New projects have been undertaken where the need has been clear. In this category might be mentioned the new project in human nutrition which was initiated in response to an appeal for nationwide investigation of foods and their effects on health and energy, particularly in regard to preservation and processing as related to the conservation of vitamins.

MAINTENANCE OF EFFICIENCY

To this work, which might be called constructive in the sense of initiating, revising, and intensifying our research as a contribution to the war effort, must be added the difficulties encountered in buying equipment and in maintaining our personnel organization. For example, precision instruments needed for our nutrition project valued at $1,200 were ordered in January and, in spite of all our preferential priorities, have not yet been delivered. Fortunately, however, we are assured of getting these particular items soon. The delay has occasioned some inconvenience. The prospects for additional equipment to be purchased in the near future are increasingly poor. Every effort will be made to exercise caution and care in the use and preservation of facilities at hand. Cooperation, planning, and interdepartmental consideration will be necessary to get the best general use from certain machines which cannot likely be duplicated or replaced for the duration.

Our personnel is being depleted both by the draft and by demands for other war work as well as for commercial enterprises requiring trained people to meet the needs of increased war efforts. Some of our most

promising and energetic young men, selected for their aptitudes and abilities and being groomed for additional responsibilities and services in our varying state services, have been called for active war duties. These men have already given such satisfactory service that an unconditional release from our institution seems most undesirable both from the standpoint of affording less security of employment to such individuals and because we cannot easily duplicate these men even under more normal conditions, to say nothing of the restricted services resulting from the universal draft. Providing for all these conditions forces us to seek temporary appointees "for the duration". Naturally any possible candidate is almost sure to be seeking a permanent rather than a temporary appointment.

CHANGES IN PERSONNEL

January 1, 1941 - June 30, 1942

In administration, Arval Erikson, assistant economist in marketing and assistant to the director, was released May 1, 1942 to take a position in Washington with the Office of Price Administration. Dr. H. C. Grinnell, assistant professor of agricultural economics, assistant to the dean and assistant agricultural economist, was reallocated in his station work to act in the capacity of assistant to the director. Dr. Grinnell returned from a leave of absence in June with his doctorate from Cornell. John C. Sim was appointed to a part-time position as editor of station material August 1, 1941. Henry B. Stevens was released from these responsibilities because of having taken over more extension work following the death of Extension Director Kendall. Howard Feindel, assistant to the treasurer, was called to the armed forces January 4, 1941. His duties were assigned to clerks in the office until February 1, 1942, when John H. Baker was appointed.

Agricultural and biological chemistry has suffered losses in some of its younger personnel. Paul N. Scripture left June 15, 1942 to accept a desirable position with another New England state research department. Various graduate students in teaching have been called by the draft and have been, or will have to be, replaced with young women.

Mary Geraghty, research assistant in Agricultural Economics, left December 20, 1941 to be married. Dean Hosken succeeded Miss Geraghty on February 1, 1942. A graduate assistant was also lost to the department.

Our soil survey work in agronomy has been disrupted because of changes in personnel. Reeshon Feuer, formerly a graduate assistant, was released to the Soil Conservation Service June 30, 1941. He was replaced by Kenneth Grant July 25, and on December 20 Mr. Grant went with the armed forces. William H. Coates, soil survey assistant, went with the Soil Conservation Service September 13, 1941. Dr. C. L. W. Swanson replaced Mr. Grant and Mr. Coates, but Dr. Swanson was a reserve officer and soon after his appointment was called for military service.

Walter T. Ackerman, agricultural engineer, resigned June 30, 1941 and has since been employed in the State by the Farm Security Adminis-

tration. Benjamin J. French, graduate assistant in agricultural engineering, completed his contract June 30, 1941 and later went with the armed services. Assistant Professor George M. Foulkrod is allocated to teaching and extension work, but he is interested in research and serves this station as an advisor and counselor.

There have been no personnel changes in animal husbandry.

A change in organization following Dr. O. R. Butler's death has resulted in a department of biology comprising botany, bacteriology, and zoology. Dr. Albion R. Hodgdon, former instructor, has been associate professor of botany, head of the botany division of biology, and taxonomist in the station since July 1, 1941. Dr. Lawrence W. Slanetz, formerly assistant bacteriologist, is now associate professor of bacteriology, head of the bacteriology division of biology, and bacteriologist in the station. Dr. Mathias C. Richards was appointed to the position of assistant professor of botany and plant pathologist in the station on March 1, 1941. Raymond W. Barratt replaced Harry West as graduate assistant in botany on July 1, 1941.

Cooperating with animal husbandry teaching, it was possible to replace Archie E. Follett, graduate assistant in dairy husbandry, with Dr. Harry A. Keener as research assistant July 1, 1941.

The only change in entomology has been the normal replacement of a graduate student. Anthony Standen takes the place of Robert Blickle as research chemical assistant.

In forestry, Lewis C. Swain, assistant professor of forestry, and William A. Johnson, assistant in forestry, were allocated a small amount of time in station work for the purpose of investigating wood waste resources in connection with possible use in the manufacture of plastics in process of investigation by the engineering station.

On February 1, 1942 three persons from the home economics staff were appointed to part-time positions with the Experiment Station. Wilma D. Brewer, with experience at the state colleges of Kansas and Washington, with the assistance of Tatiana Levcowich, former research assistant at Rhode Island station, is cooperating in the nation-wide nutrition project and is initiating some work in vitamin determinations incident to New Hampshire-grown farm products. Alice M. King, former county home demonstration agent in New Hampshire and Delaware and recently a graduate student at Columbia, was appointed temporarily to do nutritional survey work.

Experimental work in horticulture has suffered the loss of Jesse R. Hepler, associate horticulturist, who was released to Extension December 1941 for important garden work in prospect about the state, and C. Lyman Calahan, graduate assistant, who was called to army duty. A small amount of the time of Henry S. Clapp and Winfred D. Holley has been taken from their teaching and campus jobs in this department in order that they might serve as assistant horticulturists in station work.

Poultry continues to be subject to change. Carl L. Martin, veterinarian, was released July 1941 to take up private practice. His duties have

been largely assumed by Fred E. Allen, assistant pathologist. Alan C. Corbett was appointed assistant poultry pathologist September 1941. Carl W. Hess was appointed research assistant and R. O. P. supervisor October 1, 1941, succeeding Robert S. Halpin, who was released September 27, 1941 for military service. Albert E. Tepper resigned May 15, 1942 to accept a commercial position in the state. Samuel Stevens resigned as laboratory technician August 9, 1941 to accept a commercial position, and Harriet L. Goodwin was appointed to take his place. Madeline Papachristos was appointed assistant laboratory technician December 1, 1942.

PUBLICATIONS

Station Bulletins

327. Inspection of Commercial Feeding Stuffs, 1940.
328. Results of Seed Tests for 1940.
329. Inspection of Commercial Fertilizers for 1940.
330. Agricultural Research in New Hampshire.
331. Research of the New Hampshire Experiment Station, Animal Breeding and Nutrition.
332. The Local Structure of Milk Prices in New Hampshire Markets.
333. Inspection of Commercial Feeding Stuffs, 1941.
334. Results of Seed Tests for 1941.
335. Protein Requirements of Chickens at Various Stages of Growth and Development II.
336. Inspection of Commercial Fertilizers for 1941.
337. The Place of the Woodland in the Farm Organization in Coos County, New Hampshire.
338. The Problem of Moisture in Poultry House Litter.
339. New Hampshire Rural Towns' Comparative Road Burdens and Road Services.
340. Dairy Opportunity Areas in New Hampshire.

Station Circulars

56. Fine versus Coarse Grit as a Feed Ingredient for Poultry.
57. Soy Beans in New Hampshire.
58. Fertilizer Needs of Alfalfa on New Hampshire Soils.
59. Effect of Soil Moisture and Fertilizer Placement on the Vitality of the Potato Seed Piece.
60. Studies of Apple Scab Control.
61. Fertilizer Needs of Dairy Farm Crops in the Connecticut Valley.
62. Calories in Wartime.

Technical Bulletins

75. Traits that Determine the Efficiency of the Pig as a Transformer of Energy.
76. An Insect Toximeter—Studies of Contact Insecticides XV.

77. Mineral Composition of Freshly Fallen White Pine and Red Maple Leaves.
78. Studies on the Bitter-pit Disease of Apples.
79. Penetration of Oils into Insect Eggs.
    a. Influence of oil characteristics.
    b. Influence of age of egg and of species.

Scientific Contributions

79. Semi-micro Methods for Determining Copper Reduced by Sugars.
80. Isolation and Characteristics of Bacteriophages for Staphlococci in Bovine Mastitis.
81. The Influence of Three-year Rotation and Fertilizer Treatments on the Organic Carbon of Soils.
82. Relation of Weather to Prevalence of Internal Cork in Apples.

AGRICULTURAL ECONOMICS

Taxes, Types of Farming, Land Utilization, Road Financing, Farm Purchases

During the fiscal year sixteen research projects have been under way in the Department of Agricultural Economics. Three of these were in cooperation with the Bureau of Agricultural Economics and under the active leadership of personnel from the Bureau. Several are described under other subject matter headings.

Because of the urgent need for directing the Department's research resources to help in the war effort special emphasis has been made to complete the older projects. As a result ten projects including the three in cooperation with the Bureau of Agricultural Economics have been completed and the results are or will soon be published. With the exception of two projects which should be completed by the first of January, the work of the Department in the coming year will be devoted to projects that have a direct bearing on the war and postwar situations.

The Department has been called upon to do many committee tasks in connection with the War program. Members of the Department did considerable work on the report to the Bureau of Agricultural Economics on the production possibilities for 1943.

The research projects which have been carried out by the Department in the last decade have laid a foundation of economic information that is very useful to committees and action agencies in planning production and marketing of agricultural products in these times.

Local Government and Taxation in New Hampshire

The services of local government are vitally important to our rural economy. Rural people can and will look for efficiency in local government, to the support of which they contribute heavily. The taxable wealth of all municipalities in 1941 was only 43 per cent greater than in 1914, but the taxes assessed against that property increased nearly three-

fold, thus causing a phenomenal rise in tax rates. More than three fourths of all local revenues are derived from the property tax, a large fixed cost of farm production.

An interview was arranged with one or more local officials, including at least one selectman, in each of 116 towns during the summers of 1938 and 1939. None of these towns had a population in excess of 2,500.

County governmental functions are confined principally to welfare and judicial matters, and the business of the school district is confined to local administration of public education. The trend in New Hampshire is toward greater supervision and control of local functions by the state and not toward a stronger county government at the expense of the towns.

All local units of government receive revenue from the property tax. Town officials assess taxable property and levy and collect taxes for all local units of government, and then pay to other units the full amounts of their respective warrants, the town assuming full responsibility for delinquency. Of all the taxes levied by town officials, 43 per cent is paid to other units of government.

In general, town expenditures and property taxes, exclusive of state aid money, tend to bear a constant ratio to population and taxable wealth. Whether or not state aid for schools and highways expended in towns of low taxable wealth is enough to equalize the burden of taxation to the extent that they are not deprived of the necessary governmental services of standard quality is not determined by the present study.

The machinery for providing most public services involves some division of labor between the state and its subdivisions. In New Hampshire statutes rather than the constitution give sanction to local self-government, and therefore progress in improving local government requires only legislative action. State-shared revenues are found to have no particular reference to state control. State aid for maintenance of town roads is not conditioned by authority to withhold it for the purpose of enforcing compliance with a minimum standard. Town road construction financed by joint funds is under the direct supervision of the state highway commissioner. On the other hand, state aid for schools may be withdrawn if a local district fails to maintain a standard school.

The results of this study will soon be published. (H. C. Grinnell)

Attitudes of Rural Families in Back Areas

Fifty-two families were interviewed in a rural area where most of the people are underprivileged. Evidence was found that there has been a decline in the social and economic life of the people. There has developed in families a laziness, a diffidence, a desire to live with a minimum of work. Divergence from traditional mores seems to have the sanction of a large proportion of the group. The young people have rather low aspirations and make little effort to better their conditions. Many of them seem to be content to marry early and start a little camp on a small piece of land.

Special work with the young people is suggested as the best approach to relieve this circle of indifference. (Edgar C. McVoy)

Type-of-Farming Areas in New Hampshire

A study concerning the relative opportunities in commercial dairying in the many areas of the state has been completed. Brief conferences on the productivity of fields and pastures, on the type of farms, the topography, the ease and difficulties of cultivation, and on the trend in dairying were held with individuals in each town. The market outlets were noted. The land area in each town was differentiated on the basis of opportunities in commercial dairying. Then these data and maps for each town were considered and fitted into a pattern for each county and finally for the state as a whole. The final result is indicated on maps for each county and each town, and is based to a large extent on the experience and judgment of local people.

The land areas were divided into four classes on the basis of relative opportunities in commercial dairying.

1. Favorable areas.
2. Marginal areas.
3. Unfavorable areas.
4. Nonagricultural areas.

The town inventories of the state record cows on almost 13,000 farms. But over one third of them have only one cow and 60 per cent have three cows or fewer.

There were 3,940 farms reporting cows in the unfavorable areas but only 667 of these had over three cows. Only 93 farms in the unfavorable areas had 10 cows or more, and about half of these were not dependent upon economic production for their continuance.

The bulletin in process of publication is of value as basic background for extension and action programs. (H. C. WOODWORTH AND JOHN C. HOLMES)

Land Use in Grafton County

The effect of changing forest resources on local economy has been under observation in one town for a period of seven years. The stripping of the land and the effects of the hurricane resulted in the decline of assessed valuations in the town of Dorchester of 36 per cent—from $234,770 in 1934 to $148,425 in 1940.

The decline in valuations in the eastern third of the town, which contains most of the farmsteads and summer homes, has been small—from $97,485 in 1934 to $91,485 in 1940, or only six per cent. On the other hand, the assessed valuations of the wild land in the western two thirds of the town declined 58 per cent—from $137,285 to $56,820. Thus the wild lands, which had accounted for over 60 per cent of the property tax income in 1934, contributed only 38 per cent of such income six years later. The local residents and the property owners in the eastern part of the town must now carry a larger part of the burden of town government.

The town is making adjustments by gradually limiting the public services in the more isolated areas. One farm, a potential high-cost location, has been acquired by tax title and will be withheld from occupation. Eventually it may be possible to reduce the mileage of roads maintained

year round to 14 miles, and since the state is now responsible for about half of this, the cost to the town would not be large.

The most important effect of declining timber resources is the loss of future employment possibilities. It is estimated that the 76 million board feet of lumber reported in the 1934 inventory represented work for 38 men on the basis of 200 days annually for ten years. Logging operations limited even to the annual growth would have provided continuous employment for 15 men.

In the six-year period under observation the population actually increased from 98 in 1934 to 147 in the summer of 1940. The employment associated with the salvaging of the hurricane blow down and the stripping of other lands brought in a few families and probably held others.

With limited employment and income possibilities in the years ahead, the families and the town face a difficult situation. (Harry C. Woodworth and John C. Holmes)

Credit Problems in Wholesale Milk Areas

A study of the credit situation on 100 wholesale milk farms was completed and is ready for publication. The total indebtedness on the 100 farms was $178,743, or approximately 21 per cent of their estimated assets. Twenty-two reported no indebtedness and only ten indicated indebtedness in excess of 50 per cent of their assets.

Fifty-one of the dairymen carried long-term mortgage loans, totaling $146,680 or an average of $2,876 per farm. Many of the loans were contracted in the 1920-1930 period, when the average price of milk was $3.06 per hundred pounds as compared to $2.29 in the period 1931-1940. The farmers no doubt contracted their long-term obligations on the expectation of repaying them from the sale of milk at prices then prevailing. They have found it difficult to repay the loans during the years when milk prices were substantially lower.

About half of the long-term loans carried a rate of 5 per cent, and most of the rest bore a rate of from 3 to 4½ per cent.

Operators commonly reported that in their opinion certain additions to the farm plant would provide a more balanced farm organization. Twelve indicated a need for more crop land or pasture, 25 for additional cattle, 28 for more efficient equipment, and 31 for repairs of buildings. (Byron Peterson)

Financial Burden upon Rural Towns in Constructing and Maintaining Roads

In cooperation with the Bureau of Agricultural Economics at the request of the state subcommittee on rural highways, a study concerning rural highways was undertaken and completed in the fiscal year. It was found that the burden of costs of rural highways is not equitably distributed. To facilitate a more equitable distribution, the following five-point program is suggested:

(1) Revision of the Duncan Aid formula.
(2) State supervision of Duncan Aid expenditures.
(3) Reclassification of town roads so that class V roads of doubtful present and future use would be placed in class VI.

(4) The use of rural resources data in projecting secondary highways.

(5) Town development of priorities in local road improvement and maintenance.

(W. ROBERT PARKS AND JOHN C. HOLMES)

Operation of the Agricultural Conservation Program in Selected Areas

An analysis was made of the use of acreage of open pastures as one of the determinants in the allotment to individual farms in the Agricultural Conservation Program. The agency records from Merrimack, Rockingham, and Belknap counties were examined. It was found that area of open pasture was not correlated with carrying capacity. Operators who had improved their pastures tended to be handicapped in comparison with the men who had a large acreage of worthless pasture. In the same county one dairyman with 20 cows had no credit toward his allotment from his 50 acres of good pasture, but a man with one cow and 60 acres of so-called pasture was credited with $19.00 toward the allotment on his farm.

The wide differences in the acres of open pasture per cow is an indication of the difficulty of using pasture area as a determinant of the allotment. A sample of 359 farms drawn from the records in three counties was distributed according to pasture per cow. The fact that 73 operators, or more than 20 per cent, claimed over 15 acres per cow indicates confusion as to what may be classified as pasture. (HARRY C. WOODWORTH)

Freezer-Locker Plants

New Hampshire had no freezer-locker plants up to June 30, 1942, but interest is increasing. One plant is being constructed now, and more are contemplated.

Because New Hampshire conditions are much different from those in the Middle West, where many plants are in operation, it was believed desirable to bring together data which might aid in considering their applicability to our conditions.

A survey was made among farmers and others in the Laconia area. Of 100 families contacted, 42 per cent showed definite interest in a locker plant, 26 per cent showed possible interest, and 32 per cent were not interested. About two thirds were commercial farmers, of which the majority were dairymen. Almost half the families had never eaten frozen foods. Almost two thirds of the interested group had tried frozen foods, while less than one third of the disinterested group had tried them. Families with four or more at the table showed greatest interest. Half or more of those families eating 500 pounds of meat and up were interested in freezer lockers.

While more producers were interested in dressing off pork than beef, a much greater increase would be shown in dressing off beef if freezer lockers were available. Much interest is indicated in freezing fruits and vegetables.

The purchase of frozen products not raised, in jobbing lots, might be desirable to utilize lockers when home-produced products were not

available. Greatest savings are available to those who raise a variety of fruits, vegetables, and meats of good quality and fully utilize their lockers. At the same time a larger per cent of the family food needs would be supplied. (L. A. DOUGHERTY AND JOHN C. HOLMES)

Economies in Purchases by Farmers

Establishment of price ceilings, priorities, and shortages of many supplies bring new problems to farmers in making purchases. Anticipation of needs well in advance is especially important to avoid delays.

Better storage facilities for feed and grain should be given consideration in order to be ready to meet delays in transportation.

The rise in food prices makes especially important the checking of relative values of (a) package vs. bulk goods, (b) different sizes of packages or quantities purchased, (c) brands, (d) grades, and (e) sources. A check list of food and household products commonly purchased, in which brand, grade, size, source, price, and cost per pound are listed, will prove useful. Such lists will also be practicable for use in connection with food and household budgets since items under ceilings will not fluctuate as much as formerly. Investigations of this type have been pursued. (L. A. DOUGHERTY)

Areas of Supply and Channels For Marketing Milk

The main activities of this project have been associated with the War situation. A survey was made of the milk production possibilities in connection with the production goals. This was particularly desirable because of the effect of the drought on the plans of individual farmers. A circular has been printed giving results of the survey. (ARVAL ERIKSON)

The need to conserve rubber in transportation of milk and in the delivery of milk received attention. A study of the present trucking practices in the Colebrook area was made. Fifty-two trucks travel 852 miles a day in getting milk from 314 farms. There is considerable cross hauling. Plans have been developed for significant improvement through cooperation of individuals and reorganization of routes.

TYPE OF ROUTES AND MILES TRAVELED DAILY

No. of Routes	Type	Lbs. Milk	No. Producers	Miles Round Trip
9	Van bodies	47,889	198	348.5
10	Small stake	11,813	56	180.0
24	Pick-ups	13,462	44	251.5
10	Unclassified	3,429	16	62.0
		76,593	314	852.0

(ARVAL ERIKSON AND JOHN C. HOLMES)

Summer Recreation

A research project was initiated two years ago to appraise the effect of summer recreation on local economy. The report has been completed and will be published soon. The study indicates that recreational activity has strengthened the economic base of rural communities. Summer homes were among the highest producers of public revenue and the lowest consumers of public services. Average expenditures of summer residents for

local products and services were not large, but the aggregate expenditures of more than three quarters of a million dollars in the three towns provided significant portions of the incomes of year-round resident families.

Continued development of summer homes in New Hampshire is probable and desirable. The transfer of land to recreational use represents the best adjustment in many rural areas. Promotion and control of summer homes by considered public and private action can facilitate orderly development and minimize the maladjustments accompanying change. (JOHN BLUM)

DAIRYING

Dry Rations for Raising Dairy Calves and Heifers

A new calf feeding experimental barn has been added to the facilities for conducting feeding trials with young dairy stock. The new barn, located on the site of the Agricultural Experiment Station animal nutrition barns, is equipped to house 11 calves in individual pens. Specially designed mangers will make possible very accurate determinations of feed consumption.

The principal objective of this project is to investigate the use of dry rations (with limited whole milk) in which substitutes for skimmilk powder can be used satisfactorily. With the demand for skimmilk pow-

Fig. 1. Interior of New Experiment Station Calf Feeding Pens

der for human nutrition, augmented by war conditions, it is important that other ingredients be found to replace it in animal feeding.

These animals are still too young to indicate definite conclusions.

In addition to recording the usual data on growth and general health conditions, carotene and Vitamin A determinations of feed and blood will be made at regular intervals. The blood carotene and Vitamin A levels will be studied in relation to growth, the carotene and Vitamin A intake, environmental temperature, respiratory and bowel disturbances, and the minimum values for blood carotene and Vitamin A. (K. S. Morrow and H. A. Keener)

Efficiency of Dairy Herd Management Practices

Permanent records of 4,132 lactations of cows in New Hampshire D. H. I. A. herds have been tabulated on individual cards for statistical study of the relation of herd management practices to milk production. The breed distribution is Ayrshire 700, Devon 80, Guernsey 750, Holstein 1,973, Jersey 470, and Shorthorn 180. All production records have been converted to a common 4.0 per cent, butterfat basis (Gaines formula) and mature equivalent production values.

The following comparisons have been set up to date for each breed for statistical study:

1. Actual milk production vs. age.
2. Actual milk production vs. grain consumed during lactation.
3. Actual milk production vs. grain consumed during dry period.
4. Milk production vs. month of freshening.
5. Milk production vs. length of dry period.
6. Milk production vs. total length of lactation.
7. Total length of lactation vs. age.
8. Total length of lactation vs. month of freshening.
9. Total length of lactation vs. ratio of grain fed to milk produced.
10. Ratio of grain fed to milk production vs. month of freshening.
11. Ratio of grain fed to milk production vs. age.

(K. S. Morrow)

Causes of Abnormal Relationship (Ratio) Of Fat to Solids-not-fat in Milk

Fifteen sets of samples taken at two-week intervals from August 15, 1940, to March 25, 1941, comprising a total of 115 samples from Jersey and 173 from Holstein cows of the University herd, were analyzed for fat, total solids, solids-not-fat, total protein, casein, albumin, proteoses-peptones, nonprotein-nitrogen, lactose, ash, calcium, and phosphorus.

The average composition of Jersey and Holstein milk as determined by this experiment has been tabulated and summarized. Jersey milk was definitely higher than Holstein milk in total solids, fat, and solids-not-fat. Total protein and casein showed similar differences, but considerable overlapping was found in the minor constituents within the total protein component. The two breeds contained the same percentage of proteoses-peptones and nonprotein-nitrogen. Lactose and ash exhibited considerable overlapping but Jersey milk averaged higher in both. The calcium and phosphorus content was also higher and did not overlap the lower Holstein averages.

The Holstein cows were divided into two groups: six high-test cows and seven low-test cows. The lower group was studied in detail. Within this group one cow gave milk low in fat, total protein, and lactose, but unusually high in ash; two gave milk low in total protein, but average in lactose; three produced milk low in both total protein and lactose, and the last member of the group was low in total protein and high in lactose.

In general, of the solids-not-fat fraction, lactose was found to comprise over 50 per cent, total protein about 37 per cent, and ash about 8 per cent. Jersey milk contained the greater percentage of total protein, casein, albumin, calcium, and phosphorus; Holstein milk contained the greater percentage of proteoses-peptones, nonprotein-nitrogen, lactose, and ash. There was no direct correlation between the low-test group of Holsteins and abnormally low values for the individual constituents within the solids-not-fat portion.

Of the total protein fraction about 80 per cent was casein; albumin, proteoses-peptones, and nonprotein-nitrogen each contributed 6 to 7 per cent. Jersey milk was richer in casein and albumin. Holstein milk contained the greater percentage of proteoses-peptones and nonprotein nitrogen. Over one half of the low-test Holstein group remained abnormally low in casein. There was no direct correlation between the low-test group and abnormally low values for the remaining minor protein constituents.

Of the ash fraction about 25 per cent was calcium oxide and about 26 per cent was phosphorus pentoxide. Jersey milk contained considerably more calcium and phosphorus than did Holstein milk. There was a direct correlation between the low-test group of Holstein cows and abnormally low values for both calcium and phosphorus. Six out of seven low-test Holsteins gave milk low in both calcium and phosphorous.

In general the stage of lactation exerted an influence on the variations in proteoses-peptones and nonprotein-nitrogen as well as albumin. The experimental work indicates that there was such an individual variation within and between the breeds that no single constituent within the solids-not-fat portion consistently accounted for the milk's being low in solids-not-fat.

Of the ten sires used, one Jersey and one Guernsey increased milk production. Four decreased the fat percentage and increased the solids-not-fat percentage; three increased both fat and solids-not-fat percentage; two decreased both, and the other sire increased the fat percentage and decreased the solids-not-fat percentage. One Jersey sire which decreased milk production 881 pounds, increasing the fat percentage by 0.31 per cent and the solids-not-fat percentage by 0.17 per cent, and a Guernsey sire which increased milk production 1,877 pounds, while decreasing the fat percentage by 0.22 per cent and solids-not-fat by 0.13 per cent, are the only sires of the group that changed the fat and solids-not-fat from a normal relationship of fat to solids-not-fat.

The composition of milk from the dam and daughter comparison made in this study indicated that eight of the sires did not transmit a normal fat and solids-not-fat percentage relationship to their daughters

and that it is not possible to determine accurately the ability of the sire to transmit solids-not-fat by the fat test alone. (H. C. Moore and K. S. Morrow)

Relation of Conformation of Dairy Cows To Milk and Butterfat Production

Since reporting previously on this project, four cows have been slaughtered and ante mortem and post mortem data tabulated. This brings the total to twenty animals slaughtered at this station. The information on these cows has been forwarded to Washington for inclusion with similar data from other cooperating Stations.

A study of this sort assumes added practical significance as the interest in dairy type classification continues to increase. Four of the dairy breed associations are now giving special attention to type classification as a major activity of breed promotion. There still remains much data to secure before dairymen can have accurate knowledge of the exact relation between the appearance and the performance of a dairy cow. Anatomical variations and differences do exist between animals. A study of the significance of these variations will ultimately be made possible from the data secured from this project and similar ones being carried on at other experimental stations. (Cooperation, Bureau of Dairy Industry) (K. S. Morrow and H. A. Keener)

Investigations of Bovine Mastitis

Particular attention was given during the year to the study of staphylococci from cases of bovine mastitis and to the treatment of mastitis.

Staphylococci isolated from the milk of cows showing evidence of staphylococcal mastitis were found to be similar in their various characteristics to staphylococci associated with human infections. These organisms may produce both alpha and beta toxins. It was demonstrated that beta toxin is not always inactivated by heating at 100°C. for 30 minutes and that this toxin will produce typical food-poisoning reactions in kittens. These results indicate that the substances known as beta toxin and entero-toxin may be one and the same principle; also that staphylococci from udders of cows may cause outbreaks of human food poisoning if given an opportunity to grow in raw milk.

The drugs used for the treatment of mastitis included gramicidin, novoxil, aerosols, trypaflavin, and entozon; chief attention was given to the gramicidin and novoxil. Udder injections were generally given while the cows were in lactation. While the results of the treatment studies are not complete, it is evident that the cure of mastitis is a difficult problem. Gramicidin did not prove satisfactory in the concentrations used, and, while the novoxil gave somewhat better results, further study is needed before the efficiency of this drug can be definitely stated. It appears that more favorable reactions can be obtained by treating cows near the end of their lactation or during the dry period. (L. W. Slanetz and A. F. Howe)

FIELD CROPS AND SOILS

Pasture Species Under New Hampshire Conditions

Work progressed during the year on selection and breeding of timothy, red clover, and white clover strains. Several other species are being studied also as to growth habits, persistence in pastures, ability to recover after pasturing or clipping, and like factors of economic importance. These include meadow foxtail, rye grass, orchard grass, Canada bluegrass, some of the fescues, yellow trefoil, and bird's-foot trefoil.

Timothy

Plants representing two types of timothy were selected during the autumn of 1940. One of these was a vigorous, late-flowering, hay type, and the other was a shorter but very prolific, semidecumbent type which we believe may resist the effect of grazing animals to a greater degree than the more erect strains.

Plants from many sources, including 17 from native hedgerows, roadsides, and pastures, were broken up and propagated clonally. Certain greenhouse techniques have been worked out for producing seed during the winter. Seed from various selections will be ready for distribution in small quantities in the spring of 1943.

Red Clover

During the winter of 1940-41 reciprocal crosses were made among ten families of red clover that had previously exhibited a perennial tendency in the field. Seeds from these crosses were planted and these are again being hand worked in the greenhouse to fix the perennial tendency, if possible. Plants from each cross are now growing in the nursery. Potash fertilizer as favoring conditions for longevity in red clover is receiving attention.

Wild White and Ladino Clover

The F_1 generation, which represents crosses between ladino and native wild white, ladino and New Zealand, and ladino and S-100, was propagated during the summer. Fortunately, with only a few seeds, plants were secured from all of the crosses which were made in our bee-proof greenhouse in 1940. Many of these plants have the required leafiness but still lack the size that a strain of white clover should have to compete with tall grasses, a point which is one of the favorable attributes of ladino clover.

Other Species and Strains

Observations are being made on many other species and strains in the nursery and in the greenhouse. In the autumn of 1941 cuttings were taken from orchard grass plants that have been growing in the locality of Durham for twenty years or more.

From an original planting of isolated smooth brome grass plants, seven plants with a creeping tendency have been isolated and propagated clonally for seed-production purposes.

Rye grass seed of one of the improved Welsh strains was picked from a farm in Jefferson in 1940. This was propagated and the plants are growing in the nursery.

Pasture Trials of Species

New seedings were made in the spring of 1941 on the Angell farm in Lee on a Merrimack loamy sand soil involving some of the larger grasses, each seeded separately with ladino clover. Seeds for this test were supplied by the Soil Conservation Service and include creeping brome, noncreeping brome, orchard grass, Victoria perennial rye, creeping red fescue, and meadow foxtail.

Reseeding on Old Pasture Sods

During the autumn of 1940 and the spring of 1941 experimental seedings of ladino clover were made on top of old pasture sods in Durham, Fremont, and Hollis. Drought interfered somewhat with this effort, as it did with most of our outdoor work last year. (F. S. Prince, L. J. Higgins, P. T. Blood)

Advanced Alfalfa Nursery Trials

On May 27, 1941, two standard varieties of alfalfa and four new strains were planted at the Whenal farm, Greenland, New Hampshire. Each variety was replicated five times in plots picked at random. During the season weeds were kept under control. In 1942 the three middle rows of each plot will be harvested and yield calculations made.

The standard varieties are Grimm and Dakota Common. The new strains are four that did well here under the preliminary trials: A-145, N. J.; A-69, Mich.; A-67, N. J.; and A-68, Mich. (Ford S. Prince)

Pasture Clearing and Management

The program of brush removal, as reported in Station Bulletin 326, has been expanded to use a power mower, and otherwise enlarged to include a study of the most economic methods of providing adequate pasture. The economy of use of some poorer hay land for pasture, intensified production of hay on the better areas, fertilization of such poorer hay land as is used for pasture, fertilization of the better producing permanent pasture land, as well as removal and fertilization on the best pasture soils are being studied.

Nitrogen alone continues to show inadequate results either in brush or weed control or improvement in desirable pasture herbage. Lime and superphosphate are still superior to superphosphate and potash and are equal to complete fertilizer and lime in bringing in wild white clover. Although the dry season of 1941 was hard on pastures, the recovery this spring has been remarkable. There still appears to be no material difference in effectiveness of brush removal by different methods; but unless fertilized adequately, thus changing fertility level, brush soon returns.

Faced with the possible restriction on amount of nitrate of soda available, its lack does not appear to be a handicap in pasture improvement. Lime and superphosphate seem adequate at the start, and a balanced fertilizer has definite advantages over combinations of any two for later fertilization. On the basis of brush removal, the cheapest method will be adequate. This will depend on kind and amount of brush. If it can be cut with heavy duty power mower, this is as satisfactory as any method and much cheaper. Power mower plots have shown marked improvement with little brush regrowth. (Max F. Abell, Mary Geraghty, J. H. Swedberg)

Producing Full Roughage Requirements on Dairy Farms

A pasture program under New Hampshire conditions that will provide adequate late summer pasture is desired. A study to provide as nearly as possible adequate late summer pasture, with special late summer pasture plants, legume, and grass, has been instituted. One or more farms in each county have been selected and work started on a program to provide pasturage for the stock on such farms. (FORD S. PRINCE, P. T. BLOOD, C. L. W. SWANSON, MAX F. ABELL, T. G. PHILLIPS, G. P. PERCIVAL, K. S. MORROW)

Top-Dressing Old Pasture Lands With Lime and Fertilizer

This experiment was continued in two locations with certain modifications in treatment. Fundamentally, the trials are quite similar, although one is located in eastern New Hampshire and the other in the Connecticut Valley area in the western part of the state.

The Livingston pasture (Connecticut Valley) is especially responsive to fertilizer changes. Continued use of nitrogen alone even under close grazing will eliminate wild white clover, whereas changing to a complete fertilizer or to a fertilizer containing potash and phosphoric acid will cause the reappearance of clover within a month of its application, if such application is made in the spring.

Yield records from both pastures were taken in 1941, but owing to drought, yields were very low. Fertilizer treatments were last applied in the spring of 1941.

Although it was planned to discontinue work on the Seavey pasture (eastern New Hampshire), this study was continued during 1941 in order to conduct soil studies on certain treatments in both pastures which have been top-dressed over a long period.

During the autumn of 1941, ten core samples from each plot were taken on both pastures to determine changes in soil structure and organic matter content due to treatment. This work is now in progress in the laboratory and a report on aggregation and organic content should be ready in 1942. Completed under this title. (F. S. PRINCE, P. T. BLOOD, G. P. PERCIVAL, P. N. SCRIPTURE)

Legumes on Neglected Hay Lands

This experiment, which has been conducted on two farms in southeastern New Hampshire, has been active since 1926 but has undergone revision, addition, and changes. Two publications have been issued in past years. A circular is now in press dealing with newer findings and supporting data. Excerpts from the summary follow.

The data presented in the circular support previous work which indicated that the alfalfa crop responds well to annual fertilizer applications and that, judiciously fertilized, alfalfa may be expected to pay excellent returns for liberal quantities of plant food.

On one set of plots, the elements used singly returned in increased hay production $3.72, $2.29, and $1.39 for each dollar invested in potash, nitrogen and phosphoric acid, respectively.

Plots treated with annual applications of all three elements outyielded the untreated comparable checks 1.41 tons per acre each year. Individual increases for the three elements applied separately when added together total 1.31 tons per acre each year. The returns for the complete application amount to $2.48 for each dollar invested in fertilizers.

Two tons of ground limestone applied in 1926 and an additional ton spread in 1933 have proved to be as effective in producing alfalfa as four tons applied in 1926.

In a five-year trial with alfalfa on unmanured land nitrogen in the amount of 30 pounds of elemental nitrogen per acre paid good returns.

It was also found with one set of plots that 750 pounds of a 4-16-16 or even an 8-16-16 fertilizer equivalent could profitably be applied. While this amount of fertilizer may prove to be more than the average farmer would risk, it does nevertheless show the possibilities that might be obtained by liberal fertilizer use on the alfalfa crop.

Applying all the phosphoric acid and potash prior to seeding proved to be slightly superior to applying the same quantity of these materials in equal annual top-dressings. This project has temporarily been discontinued. (F. S. Prince, P. T. Blood, T. G. Phillips, G. P. Percival)

A Fertilizer Experiment with Dairy Farm Crops in the Connecticut Valley

Two circulars have been published on this experiment in past years. Upon the revision of the experiment, a rotation of crops was instituted on the field and the data that have accumulated on corn and hay crops since 1936 have been prepared for publication. Excerpts from the conclusions that are presented in the manuscript are here submitted.

An experiment involving a rotation of corn followed by a hay seeding which was harvested four seasons is discussed in this circular. The soil had previously exhibited a strong response to potash when applied to alfalfa and clovers.

In contrast to legumes, silage corn on these plots was much more responsive to phosphorus than to potash. The largest yields of silage corn were obtained from plots on which manure and superphosphate were used together.

In the mixed clover and timothy seeding which followed the silage corn potash proved to give the greatest stimulation to yields of any single substance. The response from potash was due more to the clover which persisted on all treatments receiving this element than to any other factor. The timothy on these plots, however, made a larger growth either because of potash stimulation or secondary stimulation from its association with the clover.

Used alone as a top dressing superphosphate failed to increase yields to a significant extent. Used in conjunction with potash, however, the increase in yield was more than doubled over the increase caused by potash alone.

Of the fertilizer variations tried, potash alone gave the greatest return on the basis of the money invested, but the superphosphate-potash and complete fertilizer treatments gave the highest return per acre.

From this experiment, it would seem that if red clover does not persist in the hay stand the farmer has not kept his available potash at a

sufficiently high level. If this occurs, the manure supply should be supplemented with potash in commercial form. (F. S. PRINCE, P. T. BLOOD, G. P. PERCIVAL, P. N. SCRIPTURE)

Field Corn Trials

Nineteen local flint corns and two new dent hybrids were planted at Greenland, New Hampshire, May 20, 1941. The plantings were made at random in three replications for each sample. The plants were thinned so there were three stalks to a hill with 22 hills to a plot.

On September 10 the plants were topped, and on October 11 the ears were snapped off and weighed. Twelve ears picked at random were saved and dried down to about eight per cent moisture. The moisture content was used to correct the acre yield so that all would be calculated on an equal basis.

Yield of grain corn varied from 46.47 down to 36.38 bushels per acre.

These were rather low yields per acre since the rainfall in southeastern New Hampshire was way below average during the season. The dent hybrids lead the flints in yield. These trials are continued during 1942. (LEROY J. HIGGINS)

Silage Corn Trials

In 1936 yield trials were started with fifty varieties of silage corn on a farm in southeastern New Hampshire. Each year up to 1940 some varieties have been discontinued because of low yields and various other reasons. These plantings have been replicated three times with plots of twenty hills and three stalks to a hill in each plot.

In 1940, as a result of the earlier trials, four standard varieties, Sweepstakes, Sure Crop, Golden Queen, and Eureka Tuxpan, and one double cross, Cornell 29-3, were planted as checks with seventeen of the newer hybrids. The five foregoing varieties had led all the other varieties the previous years in dry-matter yield per acre.

During 1940 and 1941 three or four hybrids have shown promise for silage corn in southeastern New Hampshire. Perhaps their yields have not always been highly significant, but some have evidenced other desirable characteristics, like standing up better in the field. It is planned to continue these trials another year. (LEROY J. HIGGINS)

Dairy Farm Rotation Problems in Southern New Hampshire with Sweet Corn as a Cash Crop

Work on this project was continued during 1941 essentially as planned. A severe drought, which covered all of New England, affected corn yields and reduced the effectiveness of heavy fertilizer applications, particularly of side dressing with nitrate of potash. This fact is revealed by the comparative yields which averaged less in excess of half a ton in 1941 than for 1940, while the gains from side dressing were almost negligible in 1941 when compared to a gain of over one ton per acre on the average in 1940.

Because the proportions of nitrogen and potash were held constant in these fertilizers a comparison of phosphorus values is possible. For the two years an average increase in yield of something over half a ton

was obtained by an increase in this element. As the 4-16-4 fertilizer cost only $0.30 per hundred pounds more than the 4-8-4 formula, there was a net gain each year from the higher proportion of phosphorus.

The averages of all plots in regard to amounts of fertilizer applications for the two years indicate a gain of 0.8 ton per acre by the use of 1,000 pounds of fertilizer as compared to 500 pounds. The increase in 1940 was practically a ton per acre and in 1941 a little less than three-quarters of a ton, again emphasizing the influence of rainfall on results.

The use of high-phosphorus formulae and the application of 1,000 pounds of fertilizer per acre, without manure, have been justified in both seasons.

As good results have been secured with manure and superphosphate as with complete fertilizers. In 1940 the yields with manure and superphosphate were better than with fertilizers alone. There is evidence from the 1940 work that extra fertilizer in the planter in addition to manure and superphosphate broadcast is a factor causing increased yields. This result was not duplicated in 1941. (F. S. Prince, P. T. Blood)

Rotation Fertility and Cultural Experiments with Potatoes

This project is located in Colebrook, New Hampshire. This is the end of the second year's work. Different fertilizer formulae, plant food levels, and methods of application of fertilizers to potatoes are being tested, and in 1941 several different nitrogen carriers were used in one series of plots. Three rotations are also in progress in this test. In one, potatoes are grown continuously, in another two-year rotation different cover crops are being tested, and the third is a four-year rotation with the usual hay crops being grown. Organic matter and soil structure studies will be made on samples taken in the beginning and at the end of a five-year period.

Variations of potash and phosphoric acid with a uniform level of nitrogen indicate for the two years that varying the potash causes much more variation in yields than varying the phosphoric acid. Also, a half ton of 8-16-16 fertilizer gave as good a yield of potatoes as an equivalent amount, 1,600 pounds, of 5-10-10.

The effects of methods of fertilizer application were checked. Yields in this respect did not vary as widely in 1941 as in 1940. Yet their relative positions were the same. The data point to the necessity of banding the fertilizer for highest yields.

Results from the use of different sources of nitrogen carriers, initiated in 1941, indicated that the less soluble or less available the nitrogenous products used, the better. The yields resulting from this factor, using equal amounts of plant food but in different forms, varied by as much as 50 bushels. (F. S. Prince, P. T. Blood, C. L. W. Swanson, G. P. Percival)

Potato Seed Certification

The potato seed certification service was started in New Hampshire in 1921. Both the field and bin inspections were under the direction of the late Dr. O. R. Butler until his death in 1940. In March, 1942, the

administration of the certification work was placed under the direction of the State Department of Agriculture. The Experiment Station will continue to cooperate with the certified seed growers and the State Department of Agriculture by making greenhouse tests on seed stocks to be planted for certification.

During the last year 112.97 acres passed inspection, the largest acreage certified in any one year since 1921. Five out of the seven growers established tuber unit plots. The seed from these plots will be used to plant fields entered for certification or sold as foundation stock.

Eighteen tuber samples taken from fields inspected in 1941 were planted in the greenhouse in Durham. The following varieties were represented: Houma, Chippewa, Green Mountain, Sequoia, Cobbler, and Warba. One eye was taken from each of 100 tubers and these were planted 5 inches apart in greenhouse beds. Typical leaf roll symptoms did not develop except in the Warba variety, and as a result satisfactory readings for leaf roll were not obtained. Even in the Green Mountain variety, where seed pieces were taken from tubers known to have net necrosis, the plants developing from these tubers did not show typical leaf roll symptoms. The plants were etiolated, with long internodes and small leaves.

In a later planting in the same beds, made in April, two eyes were taken from each of one hundred tubers. In one series the eyes were planted five inches apart; the other eye from the tuber was planted in beds at ten-inch intervals.

The plants growing five inches apart were similar to those obtained in February and March. The plants with the ten-inch spacing gave definite symptoms of leaf roll.

Tubers chosen from Green Mountain seed as having net necrosis were planted April 15 in the greenhouse. Eighty-eight per cent of the plants developing from these tubers showed leaf roll on May 15, while 12 per cent were healthy.

Other tubers were chosen as having stem end browning. When these plants were inspected on May 15 and again on May 20, 92 per cent were healthy and 8 per cent showed definite leaf roll symptoms.

These tests indicate that in the spring grading inspection tubers having net necrosis (leaf roll) may be distinguished with a high degree of accuracy from those having stem end browning. (M. C. RICHARDS)

Bacterial Ring Rot of Potatoes

Bacterial ring rot was found in New Hampshire fields in 1941 for the first time. The disease probably has been present in the state for two or three years but had not been reported. Most of the potato growers in New Hampshire purchase certified seed each year. In purchasing such seed the danger of bringing ring rot on to the farms is greatly reduced. However, when ring rot does get on a farm, how long will the bacteria remain in the soil and serve as inoculum?

Experiments set up at Durham this year to study this problem were carried out as follows. In October, 1941, ring rot infected potatoes were placed in the soil in hills at a depth of four inches and ring rot free seed was planted in these hills to determine whether the plants, if the tubers

Fig. 2. Plant Infected with Ring Rot, Showing Wilting Leaves on One side

survived the winter, would grow in the same manner as volunteer plants and show infection.

In the spring of 1942, ring rot free Green Mountain seed was planted in soil infested the previous October. Ring rot infected tubers, saved over winter, were placed in the soil in hills with healthy seed. At the present time, July 29, 1942, none of the plants growing in the soil infested in the fall of 1941 or the spring of 1942 show any of the symptoms of ring rot.

In other tests, soil to which macerated ring rot infected tubers had been added was placed in 50 six-inch pots. One half of the pots were placed in the greenhouse and the other half set in the soil outside and exposed to actual winter weather. Thirty days later (January 10) and on the tenth day of each of the months of February, March, April, and May five pots from the greenhouse lot and five pots from those left outside were planted with ring rot free Green Mountain potatoes. The plants growing in the pots were examined regularly for symptoms of the disease and in no case did ring rot develop.

Tubers produced by the plants grown in the infested soil have been saved and will be planted to determine whether the pathogen is present in the tubers but did not produce ring rot symptoms in the plants before the tubers were harvested.

The results so far indicate that plants grown from healthy seed do not readily become infected when planted in ring rot infested soil. The length of time that the organism remains viable in the soil has yet to be determined. (M. C. Richards)

Temperature Variations in Potato Bins

This project was originally planned to study temperature variations at the top and bottom of potato bins and to note losses in tubers stored under different conditions. The size and depth of bin and the effect of free air space above the bin on temperature variations were considered. Likewise, the positional effect on the potatoes in the bin on sprouting and weight losses was studied. Early in the experiment it was observed

that one of the major difficulties lay in cooling the potatoes after they were put into storage as a result of warm days that often occur during the harvesting period in the autumn.

An attempt has been made to apply this work to farm storages as well as to commercial storage houses since farm storages are more often filled beyond their optimum capacity and because there are more farm than commercial storages in New Hampshire. These farm storages are used for potatoes even though there are no provisions made for proper ventilation, quick cooling in the fall, or for keeping the temperature at the proper storage point in the spring. Insulation to keep potatoes from freezing during severe winters is often uncertain.

It has been found that the proportional space above the potatoes is not important in affecting weight losses or sprouting if a proper floor is maintained under the potatoes or if sufficient alleyway is provided around them to which a slatted floor is connected. Further improvement can be made by connecting the space under the slatted floor with an intake through which cool, outside air can enter during the fall cooling period. An air space under the floor is desirable. A slatted floor covering the entire area is preferable to the flue type. Either one is better than the ground itself to conserve the weight of the potatoes and prevent sprouting. Quick fall cooling has been found to be more important than any other factor in encouraging good keeping quality.

Condensation of moisture on the ceiling of the building and on the top layer of the potatoes, while it does not interfere with the keeping of the potatoes, does detract from their salable value and reduces the length of life of the building. This matter has been given some attention by constructing a false ceiling and connecting the intervening air space with the space under the slatted floor. This method helps remedy these difficulties tremendously but further details need investigation to perfect it.

For a certain type of commercial storage prevalent in New Hampshire, where machinery and equipment are stored in the unheated upstairs, it has been found that the openings used in filling the bins could be fitted with a wooden flue and filled with hay to provide a safe passage of moist air given off from the potatoes in the bin below throughout the winter and at the same time to prevent a rush of cold air down into the bin which might injure the potatoes.

Severe freezing during the winter of 1933-34 caused much damage to potatoes in New Hampshire storages. In many farm storages potatoes start sprouting in December. The work in this project is attempting to solve both these problems and to ensure better keeping quality in both seed and table stock. A number of larger growers have already used the results of this experiment in building or remodeling their storages, and wider use will be made of the results when they are further perfected and generally available.

Some notes on this work have been published in the Journal of the New Hampshire Horticultural Society, Vol. 2 and Vol. 3. (O. R. BUTLER, DECEASED, AND P. T. BLOOD)

Run-off, Erosion, and Methods of Control

In addition to seven run-off plots, two additional field areas have been leased in the township of Strafford, New Hampshire, for the purpose of discovering a suitable rotation for commercial potato farmers. The two areas represented are located on Paxton fine sandy loam, but they have been cropped differently so that the topsoil of each of the areas may be considered as being in a different stage of erosion.

Nonerodible.—This condition of Paxton fine sandy loam is represented by run-off plots. This area had been in sod for about fifteen years and had been top-dressed with hen manure occasionally so that the per cent of organic matter and degree of aggregation were high when the piece was plowed in the fall of 1939.

Slightly Erodible.—This condition was found in a field which had been in sod for a number of years until 1938, when it was plowed and cropped to potatoes for two years. In the spring of 1940 it was sown to a grass mixture.

Erodible.—This condition was evidenced by a field of Paxton fine sandy loam which had been cropped to potatoes continuously for twelve years.

Each of the two new fields was about three-fourths of an acre in extent, and these were laid out into 20 ft. x 20 ft. plots. The slightly erodible field was laid out on the contour, but this was not done on the erodible field because it would have cut down on the number of rotations which could have been used.

The extreme drought of the past summer prevented the seedings from becoming established. However, the fields were resown in the fall and seem to be well established.

Only two storms caused soil loss during the year 1941, and the greatest amount of soil loss for any one plot was 0.022 ton per acre or about one pound per plot. One soil loss occurred from a thunder storm on July 12, when 1.36 inches of rain fell. The five-minute intensity of this storm was 4.80 inches per hour and the thirty-minute intensity was 2.20. Practically all the soil came from the narrow space between the last contoured row and the edge of the plot because the water did not break over the contoured rows. The second soil loss was measured as a result of a rainfall of 0.98 inch on December 23 and 24, which melted a previous four-inch snowfall. The surface one inch of soil was thawed during the storm and the small amount of soil lost was removed from this thin layer.

Run-off occurred as a direct result of seven storms during the year and, in addition, occurred on fourteen days as a result of thaws which melted the snow on the plots. Only one of the seven run-offs from rain occurred during the summer months. Four occurred in the winter and spring, and the remaining two occurred in the fall. All fourteen of the thaws occurred during the winter and spring.

The crop year 1941 was unusually dry, and all the Northeast suffered from a drought.

The rate at which the soil froze during the winter was again measured for both the grass and cultivated conditions. The trend of the

curve was the same as that for 1940. However, the soil on the cultivated plots froze to a depth of 22 inches only, whereas the depth of frost in the grass plot was about 12 inches. The frost this year as last came out from both top and bottom, but during this period there was no rainfall and, therefore, no soil loss. The frost was completely out on April 17.

During the winter of 1941 a sampler for soils, combining some of the designs of both Coile and Bradfield, was developed. This sampler is made so that a 3⅛ inch x 6½ inch cardboard cylinder held by an outer casing of steel can be driven into the ground to remove a core of undisturbed soil. The sample of soil is then stored in the cardboard container for future analysis. Such samples from the plots were subjected to air space, percolation, and water stable aggregate analyses during the year with the idea of using the data for statistical treatment.

Fig. 3. A New Method of Driving and Dividing Core Samples of Soils

The presence of a large number of earthworms has been noted on the run-off plots, but no attempt to evaluate the numbers has been made except to count the numbers which are found in the tanks following a rain. Observations during the past season have indicated that earthworms may be of more importance from the standpoint of soil erosion and yield than is usually recognized.

The relative numbers of earthworms may be estimated by the number of feces left on the surface of the soil following a long rain. Observations on the three fields the past fall showed that the number of earthworms was in about the same proportion as indicated by the per cent of aggregates.

Counts of the number of millipeds found in the tanks were made at intervals during the past season. Again they caused no injury to the potatoes which were grown on the plots.

Various forest tree leaves from five soil types have been fed to the millipeds as a side project in the field of forest soils, and the results seem to be worthy of publication. This information shows the seasonal activity of the millipeds and the relative palatability of different species of forest tree leaves for food. (W. H. LYFORD, JR.)

Experiments to Determine Small Grains Adapted to Better Land Use in Northern New Hampshire

In response to farmers' requests, this project was started in 1941 to find out whether any of the newer oat varieties are superior to those commonly grown in Coos County and to determine also the feasibility of producing barley there in furtherance of the land-use program under way.

The primary tests were conducted on the "Coffin field" which is under lease by the Experiment Station, and supplementary tests were made on several other farms under the supervision of the County Agricultural Agent for Coos County.

Since most of the farms in Coos County are dairy farms that have an abundant supply of manure, and as any oat seeding is usually planted as a nurse crop, a heavy-yielding variety with a stiff straw is ideal, especially if it is to be left standing for grain. In general, the short-straw varieties lodge less than those with long straw, although there is much difference in stiffness of straw even with the same length.

Among the varieties grown, the Upright, with some lodging, was outstanding as to yield, the yield running more than twice the rate of some of the lower-yielding varieties. A local strain, picked up from a Colebrook dealer, stood fourth in the test. Three hybrids secured from the Pennsylvania Experiment Station proved to be superior as to lodging as they had very short straw, but they did not yield well. Two varieties from Canada were held up in Customs so long that the harvest date was too long delayed to make the yields worth recording. Seed for these two strains has been secured for the 1942 planting.

Yields were obtained from most of these varieties by the County Agent on other farms in Coos County. These are presented here, arranged in descending order.

Yields both from the experimental plots and from farm plots about the county indicated that Upright, Lenroc, and Gopher were consistently at the top in yields, although the "local" variety and Cornellian were close competitors. The latter was second only to Upright in the farm tests. Richland was a rather poor sixth-place winner on the experimental plots and no better on farms. However, it was a week or two earlier than the others, shelled badly, and may have suffered unduly in comparison as a result. (FORD S. PRINCE)

A Survey of the Soils of New Hampshire

This project was continued in 1941-42 by starting a survey of Rockingham County. A. E. Shearin from the Bureau of Plant Industry, Division of Soil Survey, was assigned to work with local station personnel. The survey was approximately half completed in 1941; with reasonable weather, the mapping of this county should be finished in 1942.

The Rockingham survey is of a detailed reconnaissance nature, and on a scale of 2 inches equals 1 mile. Enlarged topographic maps are used. The survey is to be made on same legend as the adjacent Strafford County survey (omitting cover or present land use). Soil and slope are to be generalized in rougher and wooded areas; that is, small and insignificant areas of soil and slope are to be included with the dominant condition. In the more extensive rough areas, slope combination may be made, eg., BC, CD, BO. Even in cleared areas, small slope areas differing only in a few degrees from the dominant slope may be included, especially when the use is not affected. Erosion symbols are eliminated in forested areas. Three classes of erosion are used: 1. slight; 2. moderate; 3. severe, with symbols for small areas which cannot be separated on scale of map.

The Podzol group of soil may be eliminated from the legend except for the small areas found in the northwestern part of the county where the Blue Hills Range extends into Rockingham County. (Coop. U. S. Soil Survey) (W. H. COATES, LATER C. L. W. SWANSON, G. P. PERCIVAL)

Influence of Soil Texture, Soil Moisture, and Soil Aeration upon Growth of Plants

During the winter of 1940-41 potatoes were grown in the greenhouse in top soils representing three widely separated textures and three soil series. Buxton clay, Paxton fine sandy loam, and Merrimack loamy fine sand were all air dried and sieved into various size fractions. Two moistures were arbitrarily chosen so that each soil fraction could be held at two different percentages of pore space. Sixty per cent saturation and ninety per cent of field capacity were selected. Total yields of tubers were found to be the easiest and most reliable indication of the effects of these treatments.

Under these conditions it was found that in general the finer the texture, the greater the yield. This same relationship seems to hold also when the plants are not grown at optimum moisture and when the pore space relationships are different, provided the soils are compared from a similar position on the moisture-yield curve.

From this work it appeared that the control of soil moisture at definite levels by the usual methods was subject to some error. For instance, per cent saturation is usually determined by saturation of the soil from the bottom of the containers in which the plants are to be grown. It was shown that this method was not accurate enough when comparing different soil types because varying amounts of air were trapped in the soil.

For the winter of 1941-42 control of this error was attempted in the following way. Total air space was obtained by packing a known weight of soil to a definite volume. Moisture levels at different percentages of saturation were calculated from the apparent and real specific gravity instead of by saturation from the bottom. In addition, compensation was made for the growth of tops and tubers by a gradual increase in the water added.

Three soil types were tested, giving a range of textures: Buxton clay, Newmarket fine sandy loam, and Merrimack loamy fine sand. The

primary aim was to discover just how yield, total air space, and moisture supply were related. Knowing the optimum moisture should allow various combinations of aggregates and textures to be compared more readily.

The yield data indicate that in general the more air space in the soil, the better is the utilization of small amounts of water. Other interesting conjectures might be made from these data, but it is desirable to duplicate and otherwise substantiate the tests before definite conclusions are attempted or any application to tillage practices is suggested.

Parallel experiments were carried on with corn and cabbage plants grown in sand and water cultures with nutrient solutions. The aim in this case was to eliminate, in so far as possible, the effects of every variable except texture. The plants were grown with their roots in nutrient solution alone, in nutrient solution with fine sand, and in nutrient solution with coarse sand. Aeration was supplied by pumping air through porous carbon tubes buried in the medium. Yield as indicated by dry weights of tops was greater in all treatments with aeration than without. Whether with aeration or without, yield was greatest in the nutrient solution only, next largest in fine sand, and least in coarse sand. (STUART DUNN AND W. H. LYFORD, JR.)

FORESTRY

During the eighteen months since the last report the Forestry Department has had an opportunity to analyze the investigations carried on under some of the older projects and to reorganize them somewhat. One of the more immediate results will be a clearer understanding of our objectives and a better program by which we can work toward them.

Plantation Studies

This project has been divided into a number of experiments which may best be organized by grouping the plantations into series. As new ideas develop, additional series may be set up so that each group will present a more homogeneous nature. To date the following groups have been recognized.

Series A: Early Plantations, 1913-1917. These plots varied in size, and only commercially valuable species were represented, including several exotics. Some data were destroyed by fire in 1937. These plantations are being examined and the records brought up to date.

Series B: Forest Trees, 1938 to date. Here again the plots are variable in size. Commercially valuable species predominate, although a few others are included in certain smaller areas in the arboretum. They are made primarily for the purpose of producing stands of timber, and the trees will normally be allowed to reach maturity before they are cut.

The plantations are examined periodically, and a staked row of sample trees is measured for height and condition, 1, 2, 5, and 10 years after planting. Usually about 10 per cent of the total number is included in the sample, up to 100 trees.

Nineteen of these plantations have been established to date with an aggregate area of 12.65 acres. Four new ones will be established this coming spring with an estimated acreage of 2.35 acres.

Tables of survival since 1939 have been compiled, also growth tables for some sixteen species of soft and hardwood trees.

Series C: Game Food Species, 1941 to date. Plantations of food-bearing trees and shrubs which are important in wild life management have been grouped in this series. These plantations may eventually be made in plots, but at present they are distributed as a row along a road, trail, or fire line. The usual number of sample trees are staked and examined for growth and condition 1, 2, 5, and 10 years after planting. Periodic examination will include data on fruit production, use by game, and other pertinent information.

Series D: Tenth-acre Plots, 1941 to date. These plots will include a wide variety of species, local and exotic, valuable and unimportant, trees and shrubs. Ten rows of ten each will be set in square plots, one-tenth acre in size. The plots will be arranged in checkerboard fashion with the alternate plots kept open. Each tree will be given a number, and complete records will be kept covering growth and condition. Root growth and root habit will be studied, as well as other silvical characteristics, such as formation of litter, effect on soil, crown closure and self pruning, crown density, maintenance of canopy, and duration and rapidity of height growth. The plots will also include material collected for the study of races and selective breeding. It is not expected that these plantations will be permitted to reach maturity, as some of the studies will involve destruction of the trees examined. This is the fundamental difference between these plots and those in Series A, B, and C.

Last year fifteen plots were established. Owing to the extremely dry summer, the mortality was very high and the average survival for nine coniferous species was only 56 per cent. For six deciduous species it was 39 per cent. Four of the plots were complete failures. This spring we are putting in four new plots, two of them second plantings of species tried out a year ago.

Series E: Direct Seeding, 1940 to date. All experiments in the establishment of stands by direct seeding will be brought together in this series. The information recorded will be as complete as seems necessary, covering not only the quantity and source of seed and the method of seeding but also the growth and development of the resulting stand. Since direct seeding was included in the original description of the project as set up by Professor Foster in 1913, it does not seem out of place to include it under the title "Plantation Studies." Unfortunately, however, no such experiment has ever been started, or at least we have record of none. It is now a part of our regular program to attempt at least one direct seeding each year.

Series F: Coppice Reproduction, 1941 to date. Since plantation studies are essentially studies of forest reproduction, it would seem advisable to include in this project an examination of the results obtained when a stand of hardwoods is regenerated by means of stump sprouts. There is little information available in the literature concerning this method.

During the winter of 1940-41 four small plots whose aggregate area totals 4.24 acres were cut over, leaving 40 scattered trees per acre to grow until the next cutting period. The stumps sprouted vigorously, and this winter an examination of about 100 stumps was made.

It is evident that the sprouting ability of the different species varies widely. The height attained the first year appears to be good, three or four feet in some cases, but it is obvious that this cannot be kept up for any length of time. It is also evident that there must be a tremendous mortality among the sprouts. A study should reveal when the mortality occurs and what the per cent is with the different species and the different sizes of stumps.

Similar cuttings are being made this year on six acres of sprout hardwood land, and we plan to include these in the investigation of sprouting ability.

Series G: Seed Tests, 1938 to date. So much of this project involves seedlings that the investigation naturally includes a study of the characteristics of tree seeds. Such items as the average weight of a thousand seeds, number of seeds per pound, viability as shown by simple tests, and the behavior when planted in the nursery have been under observation for some time. All the early records were destroyed by fire, but since then we have been accumulating data on most of the seeds used in the nursery. To a large extent these deal with exotic species, mostly conifers, but within the last year we have started working with local trees, emphasizing deciduous species about which little information has been published. (Clark L. Stevens)

White Pine Stands

This project has also been given some thought, and we have made a tentative division into sections, some of which include experiments which will require a longer period for their completion than others. We feel, however, that each of these sections is of a rather fundamental nature and has a distinct bearing on the problem of the proper management of white pine stands.

Section A is devised to determine the quantity and quality of seed produced by stands of white pine at various stages of development. Several permanent plots of from ¼ to 1 acre in even-aged thrifty stands, stocking 0.8 to 1.0, at least 80 per cent white pine, from 20 to 60 years old will be selected. All mature cones from each plot will be collected annually, and the quantity recorded. Similar studies will be made with 5 to 10 individual trees over a period of years, separating the cones from the upper, middle, and lower third of the living crown. These seeds will be extracted, cleaned, measured, and tested in various ways.

Section B involves an attempt to determine costs and results of the various intermediate cuttings in stands of white pine.

On all immature stands of white pine in the University forest, records of intermediate cuttings with the man-hours involved and the production were obtained. The date, area, location, age, and condition of the stands treated will be recorded as well as the condition one, two, five, and ten years after the treatment.

Fig. 4. Good Lumber is Still Available in New Hampshire and More Can be Grown

Section C. Some attempt will be made to determine whether or not there exist in the State of New Hampshire races or strains of white pine capable of extremely rapid height or diameter growth, or of producing narrow crowns, or with branches of unusually small size.

Stands throughout the state will be compared as to their growth habits, and seed to be planted on experimental plots in the University forest will be gathered from promising sources.

Section D. This section has not yet been thoroughly organized, but it will be concerned with the relation between the quality of the site, the stocking, or number of trees per acre, the diameter and height growth, and the quantity and quality of lumber produced. Up to date this section has merely been set up as a part of the main project.

Section E. Grouped under this section will be those problems connected with the measurement of white pine logs, trees, and stands; the preparation of volume tables, taper tables, and yield tables; the grading of logs.

Section F. The objective here is to compare the results obtained by various silvicultural systems, and, if possible, to develop a system by which white pine should be cut in order to secure satisfactory natural reproduction.

Section G. This section will be composed of studies connected with the utilization of white pine; the strength, weight, and hardness of the wood; logging practices and costs; milling and manufacturing methods and costs; lumber grades; marketing problems; use of waste material; by-products.

In most cases the utilization of forest products has a pronounced influence on the program of forest management, since the forester must

produce what the market needs, in the form desired. Although we have not yet set up the objectives and methods to be followed, there are plenty of them from which to make a selection. (Clark L. Stevens)

Spruce Reproduction

Only a small amount of work has been done on this project, and most of the funds assigned to it have been relinquished. Since the project involves travel to the northern part of the state, it appears that the best method of carrying it on will be to combine it with work at summer camp during July and August. (Clark L. Stevens)

Fence Post Durability

The observation of fence post durability has been continued, but no money has been spent on this project during the year. The annual spring check on the condition of the posts shows no measurable change. (Clark L. Stevens)

Determination of the Supply of Low-grade Wood Available for Manufacture into Plastics

Before lumbering became one of the leading industries in New Hampshire, the subject of waste in connection with woods operations was of little importance. Trees grew to maturity and died, their remains falling to the ground to become a part of the soil from which they arose. The gradual addition of dead and dying woody material to the litter was beneficial rather than a detriment to forest growth.

Concurrent with the first large-scale logging operations, an overabundance of slash, the discarded portions of trees, began to be left on the ground. Not only was the slash of small value in soil building, but its presence constituted a severe fire hazard and a breeding place for insects and disease.

Waste as it occurs in woods operations may be classified as follows: stumps, tops, limbs, defective and broken logs, improper log lengths, transportation and storage decay. These losses, when averaged among various species and regions, have been determined as 20 per cent or even higher in relation to the standing tree. During manufacture additional waste accumulates, such as bark, sawdust, shavings, edgings, trimmings, slabs, and seasoning defects. Varying with the industrial use, manufacturing may add another 40 per cent, so that of the original tree less than one-half is economically useful.

In attacking the problem of the determination of woods waste, recognized forest types were located within which sample plots one-tenth of an acre in size were established. From the results so far obtained, it is rather easily seen that the amount of wood waste in any particular stand varies with its age, composition of the stand, and the quality of the site on which the trees are growing. Thus, in stands of white pine which are 60 to 80 years of age, where the trees are tall and symmetrical, the waste is relatively low—in the vicinity of 9 per cent of its total volume. On the other hand, trees in the same age class which are of the type commonly known as pasture pine show a waste volume slightly over 49

per cent. Again, in the case of younger stands where trees are continually dying by suppression, it is shown that the waste volume runs all the way from 49 to 52 per cent.

In young hardwood stands most of the material can be used for fuelwood. Consequently, it is uncommon to find waste running higher than 7 or 8 per cent. Some stands may be classified as overmature and, if suitable means can be found for their operation, they should prove a good source of supply for plastic materials.

Pulpwood operations yield a small amount of waste because of the practice of cutting to a 4-inch top diameter. From data secured at several pulp operations, it is shown that waste including stump, limbs, and tops varies from 3.56 per cent to 4.14 per cent of the total volume of the tree.

Preliminary studies in white pine boxboard waste at portable mills show that from 30 to 33 per cent of the log goes into slabs and sawdust. From the results so far obtained, it is apparent that more waste is produced during the milling process than in the woods, and that this mill waste can be handled more economically than woods waste. (LEWIS C. SWAIN)

Sugar Maple Propagation

No travel around the state was undertaken by the forestry department because of the emergency, and all funds have been relinquished.

This year's work consisted of a few tests on local trees carried out principally to determine the method to be used. It was found that the refractometer can be carried into the woods and used beside the trees, provided it can be held in direct sunlight.

It is not necessary that the trees be tapped for the test, as clipped twigs were found to yield enough sap in one or two minutes. Small trees were tested in this manner, and the results indicate that we will be able to check the results of the propagation work without waiting more than two or three years for the trees to get big enough to produce sap.

As a supplement to the other work, 18 daily runs of sap from a single tree were brought into the laboratory and converted to syrup.

The year 1941 was poor for seed production by sugar maple and we have not been able to start propagating from seed. This spring, however, the trees set a heavy crop, and we plan to collect enough this fall for a series of experiments.

Greenwood or new-growth cuttings were taken from twigs of very old maple trees beginning late in July. They were given varying treatments both as to media for rooting and hormones. Marked clonal variation was found from the highest of 15 per cent rooted with water only and 10 per cent with a treatment of 50 mg. of indolebutyric acid per liter down to zero response.

Total mortality was also obtained with cuttings placed in sand and peat and then placed in a refrigerator at +8°C., with and without hormone treatments. Cuttings similarly treated and placed in a mixture of sand and powdered manure in outdoor beds were also checked.

On July 18 a large number of cuttings of various ages of wood were

gathered, foliage stripped off, and after various hormone treatments buried in a peat and sand mixture with bottom heat of about 30°C. These remained alive for months but showed no rooting. Others were buried in outdoor beds in October and November. Many remained alive until spring, but no rooting or callusing developed.

No positive results were obtained in treating cuttings with dilute solutions of potassium permanganate. (C. L. STEVENS AND STUART DUNN)

Woodlots in Farm Organization in Coos County

A cooperative project for the Bureau of Agricultural Economics and the New Hampshire Experiment Station has been completed. It was found that woodland resources are not well distributed among the farmers of the Colebrook area. Farmers in the area have attempted to adjust the size of their herds and the acreage of crops to fit into an economic unit, but they have neglected to give proper consideration to the woodlands in their plans. The income of the whole area could be raised by a greater utilization of the available man power in slack seasons. An analysis by the budget method indicates that many farmers could increase their net income by adding additional woodland and including a definite woodlot management program in their farm organization. (In cooperation with Bureau of Agricultural Economics.) (JOHN C. CHANDLER)

FRUITS AND VEGETABLES

Effect of Fertilizing Elements on Apples

Further tests were made in an attempt to discover whether "arrowhead" leaf scorch is a soil-plant relationship. Some evidence that such is the case, at least in part, was offered as a result of pot tests during the summer and fall of 1941. Soil samples were obtained beneath the tree most severely affected by this scorch at the Hewitt orchards in Walpole and beneath a normal healthy tree. The soil from beneath each tree was put into one-gallon lacquered tomato cans. Soil from beneath the severely affected tree received the following amendments: molybdenum, calcium, magnesium, potassium, and zinc, also combinations of calcium and magnesium, calcium and potassium, and potassium and magnesium. One control received only tap water, another distilled water.

Seedlings of Wealthy apples were planted in the pots. Growth was best wherever calcium was used, the best growth being obtained where calcium and potassium were used in combination. Good growth was also obtained with magnesium alone and with potassium alone, also with zinc. No growth occurred where distilled water was used, and the plants died before the test was concluded. Those watered with tap water grew very slowly and were not much larger at the end than at the beginning of the test. No better response was obtained with soil treated with molybdenum. Plants in pots receiving a combination of potassium and magnesium failed to make appreciable growth throughout the period. Leaves were severely scorched on trees making poor growth, although the type of scorch occurring on these leaves was different in character from the scorch observed in the orchard. Trees making the best growth

increased 800 to 900 per cent in height over that observed at the beginning of the experiment, while those making the poorest growth increased only 25 to 50 per cent. On the poor trees the leaves were also small. Zinc was used in the tests in an attempt to determine the cause of small-sized leaves as it is known that in some soils many plants develop small leaves because of a zinc deficiency. Trees grown in soil taken under the healthy tree grew rapidly and generally made as good growth as the best trees in the treated soils described above. That the two soils differed from each other was otherwise evidenced by the difference in certain characteristics of the trees. The soil beneath the scorched tree was lighter in color and texture and apparently of poorer water-holding capacity than the soil beneath the healthy tree.

When samples were taken in the orchard it was noted that the "feeding" roots of the badly scorched tree mingled with the grass roots just beneath the soil surface and were not found below this level. The "feeding" roots of the healthy tree penetrated the soil more deeply. This test is being repeated.

In the fall of 1941 data were collected for the construction of correlation tables in relation to visible tree characteristics in both the Goodwin and Hewitt orchards. From this data partial correlations were calculated and compared favorably with values obtained in 1940. There was a highly significant positive correlation between scorch and defoliation and between the amount of scorch on the tree and the degree to which the leaves were affected.

Observations have been continued on apple trees receiving borax in the orchard. Only trees sprayed with a saturated solution showed any injury to the leaves. Where borax was applied to the soil, trees receiving less than 5 pounds of borax in 1940 are healthy. Heavier applications result in trees possessing smaller leaves of paler color due to apparent deficient chlorophyll production between veins. Young fruit on trees which received 10 and 20 pounds of borax was yellowish rather than normal dark green. These trees showed no apparent ill effects following borax application in 1940. Interesting effects of borax on growth of apple trees in the greenhouse are being checked concurrently. (L. P. LATIMER, G. P. PERCIVAL)

Use of Malling and Other Dwarf Apple Rootstocks

Observations on the production, size, and stability of trees of the several varieties on various rootstocks were made. Results to date show that the trees on Malling No. 3 and Malling No. 4 planted in 1938 have been very productive, especially with the variety Golden Delicious. There is some indication that some of these varieties even on No. 4 have been so precocious as to dwarf the trees unreasonably, rendering them too small for commercial planting. However, in general, trees on No. 4 seem to be behaving nicely in obtaining size and productivity for a commercial orchard. Observations in the grafted orchards where varieties of McIntosh, Spy, and Cortland have been worked onto the body stock of Virginia Crab and Florence Crab indicate that the growth has been much better on the Florence Crab than on the Virginia Crab. There is

also some indication that some of the red strains of McIntosh apples are not completely compatible with the Virginia Crab. Ring grafts of purple-wooded apple trees were made on white-wooded apple trees, and white-wooded rings were grafted onto the purple-wooded trees. At intervals of 1, 2, and 3 years these grafts will be sectioned to determine if the wood originating from these ring grafts is regenerated from the stock or the scion. This information should give evidence as to whether the influence of a ring graft is due to the characteristic of the wood grafted onto the tree, or if it is due to the wound injury. (W. W. Smith)

Fruit Bud Formation

This project has been carried on since 1908, but will be discontinued at the close of this year. Mainly as a result of its operation, the use of nitrogen as an apple orchard fertilizer has become standard practice in almost all orchards in this state. The desirability of early thinning of apples has been demonstrated, and the beneficial results from use of mild sulphur as compared to lime sulphur have been shown. Recommendations based on these results have been generally accepted and applied by the fruit growers of the state. (A. F. Yeager)

Premature Dropping of Fruits with Special Reference to McIntosh Apples

The apple drop problem has apparently resolved itself into tests with hormone sprays consisting for the most part of naphthalene acetic acid. Although some early varieties may be induced to hang on the tree almost indefinitely following sprays of hormones of this type, McIntosh does not seem to show such favorable response. Rows in the orchard were sprayed just before the apples began to drop. There is some belief that warm weather is a factor in causing the hormones to be effective. Since McIntosh ripens during cool September and October weather, one row was sprayed with a hot solution of this material. In no case where trees were sprayed was the drop prevented in the orchard. As a check on orchard operations, certain branches on two trees were selected and sprayed carefully by hand. There was some variation with individual branches.

On branches sprayed September 10 there was little difference in the per cent of drops from the controls. Branches sprayed for the first time on September 22, after considerable dropping had occurred, showed some decrease in the amount of dropping compared to the control. At this time trees sprayed on September 10 were again sprayed, but dropping was not so effectively controlled as with the single spray of September 22. As a whole, the result from spraying McIntosh with hormones to prevent drop was not promising. In some orchards in the state growers have felt that they have received beneficial results from hormone sprays in that they picked apples with higher color than from trees not sprayed. (L. P. Latimer)

Changes in Apples During Ripening and Storage

The storage disorder brown core occurring in McIntosh apples has been given special emphasis the last few years in our storage studies.

Apples harvested from half of trees receiving nitrogen and half of trees receiving no nitrogen for the last three seasons were held in storage and compared for the development of brown core. Also, apples from the north side were compared with apples from the south side of the same tree. When these data and similar records taken over a period of five years were compared, there were indications that in some years apples from trees low in nitrogen were less subject to the occurrence of brown core than apples from high-nitrogen trees. Also, apples from the south side of the tree were less susceptible to brown core than apples from the north side of the tree. However, these differences were very small compared to the seasonal differences, and in years when the appearance of brown core was severe the differences due to treatments were negligible in comparison with the total amount of brown core occurring.

The prevalence of brown core in relation to weather conditions was studied. There seemed to be an association between wet growing seasons, or low temperatures during ripening, and the occurrence of brown core. Internal browning, a disease similar to brown core occurring in Yellow Newton apples, was found to be associated with low-temperature growing conditions in the Pajaro Valley of California, and our records show that in wet growing seasons, or seasons when the temperature has been low during the ripening of the apple, brown core has been most prevalent in our stored fruit.

One of our cold-storage rooms was made gas-tight by using paint prepared by the DuPont Company, with a bicycle inner tube gasket around the door and grafting wax for sealing up the cracks. Four hundred bushels of apples were placed in this room, and the concentration of carbon dioxide was kept between 11 and 12 per cent and the temperature at 40°F. This experiment demonstrated that a cold storage may be made tight in this way without too much expense. Apples kept in this modified atmosphere were free from brown core and until the last of March were more crisp and harder than apples stored at 32°F. However, the lots removed in April developed scald quickly and had a flavor that was apparently caused by too high concentrations of carbon dioxide. This injury may have been due to a drop in the temperature to 36°F. for a few days in April, when the concentration of carbon dioxide was about 12 per cent.

Some study has been initiated this year on the use of ice as a cooling material for apple storage. Several storages already using ice for cooling were investigated and critically analyzed. On the basis of these studies an ice bunker was designed and a model built. The object of this ice bunker is to melt the ice quickly to release more cold into the room than would come about by ordinary melting. The ice bunker was designed in a unit size so that as many units as were necessary could be placed in the same storage, each unit working independently. It seems that at this time with emphasis on conservation of energy and of food the use of natural resources such as ice is a worthy war-effort project, and indications are that it is good economy. (W. W. SMITH)

Marketing McIntosh Apples

In this apple marketing study about three hundred retail stores and a small number of growers were contacted. Samples were taken in about half the cases. A report on condition was secured by referring samples to the horticulture department. Test sales were also made in two chain "supermarkets."

About 40 per cent of the chains and 78 per cent of the independent stores contacted bought apples from New Hampshire growers. Apples delivered from cold storages showed 22 per cent less waste than those from common storage. Also, apples sold from the original box showed 42 per cent less waste and 50 per cent fewer large bruises than those from bins and counters.

In test sales in "supermarkets" over half the McIntosh sales for the week were made on Fridays and Saturdays. The rate of sales was twice as great in the afternoon as in the morning. Large-sized (3 inches and up) apples sold best and brought largest profits to the retailer. Bruising seriously reflected on sales, and apples showing conspicuous damage sold only one-third as fast at one-fourth the profit as apples of the same grade which were not conspicuously bruised.

Facing stimulated sales; faced McIntoshes sold four times as fast at retail and for more money than unfaced ones taken from same box. Retail packages for McIntosh have not sold well. Neither the package nor fruit in it appeared to meet the demand for a package apple. Special retail boxes or trays which would serve satisfactorily for display may aid in reducing handling and bruising in the stores. The retail package must display the fruit and be inexpensive.

Some growers and stores have demonstrated that McIntosh apples can be handled with a very small amount of injury. The care taken and method used are more important than time or expense in prevention of bruising. (L. A. Dougherty, Mary Geraghty, A. F. Yeager)

Winter Injury, with Special Reference to the Apple

Trees treated with high concentrations of nitrogen on one side and no fertilization on the opposite side, as previously described, were analyzed chemically for differences in nitrogen and sugar content of the tissues of the trunk. The conducting tissues were separated and analyzed. The analyses indicated a seasonal variation, with a building up of sugar during the winter and a sudden reduction in the spring. No differences could be shown between the treated and nontreated sides of the apple tree. It was expected that if a low sugar content could be shown on the treated side of the apple tree, it would explain the reason for the side of the tree treated with high nitrogen being more susceptible to winter injury. Samples of tissues from these different treatments were taken and are being studied for anatomical differences. (W. W. Smith, T. G. Phillips, C. L. Calahan)

Apple Pruning

Trees set out in 1926 were pruned again this year as in 1940 and 1941 according to two systems, the conventional and the thinwood method. The yield, size, and color of fruit from trees pruned by the two

methods have been recorded and compared. There is little difference in size and color of fruit, but a slightly larger yield from the thinwood pruned trees. (HORTICULTURE DEPARTMENT)

Spray Management

The total amount and volume of the spray material applied by 32 orchardists was computed and analyzed for a series of five years. It is difficult to make comparison between orchards because of differences in yield, age of trees, and other variables. The best comparison seemed to be on the basis of the normal expected yield from trees of the given age. On this basis the cost of spray material varied from 1.4 to 15 cents per box. Some of the difference in material cost can be accounted for by the number of sprays applied, but some operators apply more material on each spray than others. On 23 of the 32 farms, the cost of material was less than 5 cents per box of apples.

Since all operators applied the calyx spray, using approximately the same materials with the same objectives in view, a comparison of the cost of materials for this particular spray should indicate the differences in procedure in the various orchards. The cost varied from 0.5 cent to 2.7 cents. An important point is that the material cost for the calyx spray on 17 of the farms amounted to one cent or less.

Under the usual organization of a specialized apple orchard, spraying is an important operation and the cost of the spray material is the chief variable cost factor. The available help and the equipment tend to be fixed cost factors, especially on family-sized specialized fruit farms. Thus on farms that have the equipment to apply spray efficiently, the additional cost of a marginal spray is very small. The decision as to the application of a spray should be based on a comparison of marginal returns expected in better quality of the fruit and the marginal costs which in this case are largely spray materials.

On this basis, the orchardist with available labor and equipment could afford to put on the additional spray if he estimated it would tend to raise the value of his crop a few cents per box. If he had other high value uses for his available help and for a portion of his equipment, the cost of the "marginal" spray would be higher. The returns expected from the spray would have to be more substantial to make its application economic.

Some of the producers are omitting one or more of the generally accepted sprays. Since the application of the one spray reduces the actual cash cost on specialized farms only about one cent per box of apples, its elimination is not advisable if there is substantial risk in loss of quality. (HARRY C. WOODWORTH, MARY GERAGHTY, BYRON PETERSON)

Blueberry Improvement in New Hampshire

Seedlings are being grown from crosses made of selected lowbush blueberries having light blue color and the improved highbush variety. About 50 seedlings were obtained of these crosses and carried over the winter in flats in the greenhouse. These were planted outdoors this spring, but as yet are very small plants. Observations and search for outstanding wild blueberry plants are being continued.

To increase our own number of improved blueberries, a number of hardwood cuttings were placed in propagation frames. Two years ago attempts to root hardwood blueberry cuttings with the Maine peat were disappointing. However, trials repeated last year, loosening up the State of Maine peat with mixtures of sand, brought better results. This year sand was again used to loosen the peat, with indications of a fairly good stand of cuttings. (W. W. Smith)

Establishment and Development of Lowbush Blueberries

Work on this project was begun last fall to determine the satisfactory procedure for establishing and maintaining blueberry plants on abandoned farm land. Areas of thick gray birch and young pine under which blueberry bushes could be seen growing were cleared during the winter and burned over this spring, and a fairly good stand of lowbush blueberries resulted. Similar areas cleared of wood but not burned are being used for comparison, and studies are being made of these two areas to determine the ecological diseases and insect changes due to the different treatments. Areas in abandoned fields were plowed and blueberry fruits spread on these areas. Various techniques were used in an attempt to start young plants from fruits. On other areas the plants, including the rhizomes and underground roots and stems, were disked into the soil in an attempt to establish the young plants. In other areas furrows were made in which the young plants and pieces of rhizomes were laid and the furrow turned back. The furrow technique of transplanting was repeated again this spring. In both cases most of the plants remained alive and seemed to be doing well. In none of the fruit treatments is there any indication of plant growth.

Observations of the burnover areas indicate that three stages may be obtained: (1) Burning so lightly the stems are not killed but only injured around the base. These plants will continue to have fruit the following year, but will be in a weakened condition and may have red foliage. (2) Burning hot enough to kill the stems but not the crown, so that new shoots come out from the crown. This is the usual type of burning. (3) Burning enough to injure the crown, in which case underground stems shoot out to form new shoots. This type of burning may greatly improve the spreading of the plant or clone.

Observations on blueberry plantings indicated that those plantings which suffered most from drought last summer are the ones which were injured by the cold during the winter. (W. W. Smith)

Strawberry Breeding Tests

In 1940 eight wild strawberries were transplanted from the field to the Horticultural Farm. These berries were selected as having superior flavor, size, and vigor of plants, as well as a good set of fruit in the cluster. One of these, a perfect-flowered form which is rare in the wild strawberry, has been propagated for breeding purposes.

In 1940 some of the best wild fruits were saved and the seeds planted. These plants were transplanted to the field in 1941. In 1942 it was found that a large percentage of the pistillate blossom plants produced a large crop of good-sized wild fruit.

Crosses were made between the most promising wild types and the most promising cultivated varieties. Crosses were also made between different promising cultivated sorts. The object is ultimately to obtain a heavy-yielding variety, and one that possesses winter hardiness, drought resistance, good quality, and preferably late maturity. By using wild type in crossing it is hoped to obtain some of these characters in the cultivated fruits. Twenty-five hundred or more seedlings of these crosses are being planted this year. (L. P. LATIMER, A. F. YEAGER)

Thinning Strawberry Plants

The yield from the 1940 bed showed that thinning runner plants with Howard 17 made little appreciable difference in the total yield obtained. In 1942 results showed reduced yield over unthinned plants. When only eight runner plants were allowed to set per parent plant, a significant reduction in yield was obtained over the control. Under this treatment the yield was approximately 60 per cent of that obtained in the unthinned rows. (L. P. LATIMER)

Winter Storage of Strawberry Plants

Plants that had been stored in moss, sawdust, peat, and sand were compared with those transplanted directly from the field in the spring of 19 . When stored at 32° from November until planting time in May, peat proved to be the best medium. The number of runner plants formed during the season was greatest with the peat-stored plants. This was significantly greater than those stored in sawdust or moss, or those formed by plants that were field dug, and significantly better than those stored in sand. The fewest runners were formed on plants that were stored in sphagnum moss. There was little difference in the number of runners formed between field-dug, sawdust, and sand-stored plants.

Although plants that were stored in peat or transplanted from the field gave the greatest yield, the difference between the yield of these plants and of those stored in sand, sawdust, and moss was not statistically significant. Plants stored with roots bare were dead upon removal from storage. (L. P. LATIMER)

Variety Trials with Strawberries

Twenty-four varieties of strawberries were compared for yield in 1941. Pathfinder was the only variety giving statistically significant values, greater in yield than Howard 17. Dresden yielded next to Pathfinder and apparently slightly better than Howard 17. The yield of Frostproof, Sheldon, and Campbell's Early was also good. North Star had the lowest yield of all, yielding but a quarter as much fruit as Howard 17. The plants of North Star were vigorous and the rows were wide. New York and Narcissa were also poor yielders. Dresden and Pathfinder were the only ones considered worthy for trial as new varieties by the growers. Variety trials for 1942 included about 12 additional varieties, Cresco alone coming up to Howard 17 in yield or in other qualities. Dresden and Pathfinder again were the two varieties which rivaled Howard 17 in production. (L. P. LATIMER)

Borax on Strawberries

In 1940 borax was applied to a strawberry bed during the early spring of the second year of growth. Although there was some reason to believe that the soil in which the plants were growing might be deficient in boron, the yield was not improved. When the borax was applied at the rate of 50 to 100 pounds per acre some injury was noted in the plants. The berries were somewhat inferior, and the yield was cut down.

A bed that was set in 1940 was treated with borax about the time the first runners were formed in early August. The best yield was obtained in 1941 from plots which received 25 pounds of borax per acre and on those which received no borax. Although the yield was smaller on plots that received 50 pounds of borax, it was not significantly less statistically than that obtained with lesser amounts. One hundred pounds of borax caused a significant increase in yield and 200 pounds still more. In this test there was a high correlation between yield under the different treatments of borax and the number of runners formed per plant. With 100 and 200 pounds of borax, fewer runners were formed than with lesser amounts or with the controls. The correlation was .898. (Horticulture Department)

Raspberry and Blackberry

The best of the old varieties, the most promising of the new, a number of foreign species and a collection of promising wild material are growing in the test plot. Some of the most promising of these have been crossed in the greenhouse with the object of producing raspberries and blackberries that will be satisfactory in this section. Ordinary cultivated varieties are subject to severe winter injury. (Horticulture Department)

Variety Tests of Other Fruits

Of all the varieties in the new planting of grapes, Kendaia has shown promise of being hardy and vigorous, producing mature vines at an early age. Among the peaches Cumberland seems to be the most hardy in fruit buds during the winter. In 1941 it was the only variety that produced any quantity of fruit. From appearances the same will be true this year. (L. P. Latimer)

Variety Trials of Fruits and Vegetables In Northern New Hampshire

Variety trials were begun this past season on a small scale and are being expanded to a considerable extent. Plants and seed are being furnished to cooperators who report on their behavior. In this way it is hoped to determine which of the new varieties are adapted to the northern area of the state. Some of our breeding material also shows promise for that section. Some of this work was requested by "land-use planning" participants. (Horticulture Department)

Breeding Improved Tomatoes

New Hampshire Victor, a strain of similar breeding to the standard Victor, except more disease resistant, was distributed to growers in the

state during the year. Orange King, a tangerine-fleshed determinate variety, was distributed for test, as was Home Garden, an extremely early variety that is comparatively small in size but of fine quality. These are most valuable in home gardens and in parts of the state where the season is shortest. A large number of foreign plant introductions are being tested for disease resistance. Crosses between the most promising of these and standard varieties have been made. Two additional generations, in addition to the field crop, were grown in the greenhouse, one in the fall and one in the spring. (A. F. YEAGER, J. R. HEPLER)

Developing Disease Resistance in Early Tomatoes

In developing new early tomato varieties for New Hampshire, a project carried out by the department of horticulture, a search has been made to find parent stocks resistant to early blight. Of the four diseases which are common in New Hampshire, early blight, late blight, blossom end rot, and Cladosporium blight, the first is the most important.

During the past year seventy commercial tomato varieties and selections from crosses were tested in the field and in an inoculation chamber in the greenhouse for resistance to early blight. All of these were found to be susceptible to the disease when placed under favorable conditions for infection. Several other species and selections of tomatoes obtained by others from South America have been grown in the greenhouse and are now being tested in the field.

Although none of the plants tested was immune to early blight, there was a wide range in the amount of defoliation and injury caused by the pathogen under field conditions. In general, those plants which had a heavy fruit load in comparison with their foliage had the most disease. As a result of these tests, and taking into consideration the findings of other workers, it is believed that fruit load, available soil nutrients, spraying with fungicides, water content of the soil, date of planting, and variety —factors which hasten or induce physiological maturity in a plant—will increase the susceptibility of that plant to early blight. (M. C. RICHARDS, R. W. BARRATT)

Muskmelon Breeding

No varieties are ready for distribution as yet, but some high-quality strains which possess perfect flowers and some extremely early, high-quality melons not possessing perfect flowers have been isolated. The combination of extreme earliness, high quality, and perfect flowers has not yet been obtained in pure form. Attention is now being given to the disease resistance of selections under test. (A. F. YEAGER, J. R. HEPLER)

Searching for Disease Resistance in the Muskmelon

Investigations during the past year revealed that three diseases, powdery mildew, downy mildew, and anthracnose, are of importance in causing losses to muskmelon growers in New Hampshire.

In the muskmelon breeding program, as carried out by the department of horticulture, two crops of melons are grown in the greenhouse during the fall and winter months. In the greenhouse powdery mildew

is abundant and causes serious injury to the plants. Until mildew resistance is introduced into the breeding lines it is necessary to control the mildew in the greenhouse by means of fungicides.

Muskmelon foliage, whether in the field or greenhouse, is readily injured by some fungicides. Therefore, the problem is to find a material which will control mildew and not injure the plant. As sulfur is known to be toxic to the mildew pathogen, three sulfur compounds, Kolofog, Koppers flotation sulfur, and potassium sulfide, were used in various dilutions ranging from ¼ pound in 100 gallons of water to 6 pounds per 100 gallons. Severe burning of the foliage occurred in all cases. Temperatures in the greenhouse varied from 70°F. to 95°F.

The following copper compounds were also used as sprays: Copper-oxychloride sulfate, 1-100 to 2-100; Bordeaux mixture, 1-150; Cuprocide, 1-100. Of the copper compounds, Copper-oxychloride sulfate was the most satisfactory. However, some injury occurred with this material at the concentration used.

Several organic fungicides have been obtained and will be tested in the greenhouse this fall for the control of powdery mildew. (M. C. Richards, R. W. Barratt)

Squash Storage

A new project has been initiated this year with horticulture and several other departments cooperating. To date, only preliminary work has been done. Squash stored in the apple cold storage proved to be the most satisfactory in quality this year. Squash put in an air-tight container developed carbon dioxide until actually more than 99 per cent of the air was CO_2. This result would indicate that modified air storage will probably not be successful with squash since respiration is not checked when oxygen is exhausted. (Horticulture Department)

A New Bean

A white-seeded, small-pod, green bean is being developed with the idea that it might be useful as a whole canning bean. Several strains are nearing purification and are ready for tests this season. While these seem to meet specifications fairly well, there is always a question whether they will be acceptable to the trade. (Horticulture Department)

CONTROL OF INSECTS

The urgent needs of a critical war period are reflected in the research program of the Department of Entomology. As soon as the United States entered the World War the department adapted its investigations to war needs.

Fortunately, the work of the department was already largely centered on studies of spray materials. Two major investigations have been under way for a considerable period, including studies of contact insecticides and research in the performance of ovicides. The objectives in each case were to discover fundamental facts as to the performance of these

two groups of chemicals. This program, while still leading toward discovery of fundamental facts, has been adapted and modeled to give it a concrete and immediate aspect—a search for new and more effective chemicals with which to control destructive insects.

The department has exceptional equipment for this purpose. Its research laboratories were designed for its fundamental work in insect toxicology. A new apparatus, built by the department, is developed for the purpose of impregnating inert dusts, such as clays and talcs, with chemicals. Another apparatus has been set up to measure the potency of new chemicals that may serve to kill insects.

Some of the ingredients that have long been used in the United States for manufacture of sprays are already scarce. Some are imported from regions that are in the heart of the war. The department is searching for synthetic compounds that can take the place of materials that are scarce or unobtainable.

Two synthetic chemicals, which may rival the performance of pyrethrum extract, are under investigation. Pyrethrum extract, made from flowers grown in Kenya Colony, Africa, is becoming more difficult to obtain. In another series of studies a new fumigant has been developed.

Penetration of Oils into Insect Eggs

Studies were concluded in which penetration of various types of oils into insect eggs was determined. The petroleum oils employed in this investigation included successive viscosities. In addition, the series involved terpenes and a fixed oil.

It was found that penetration was accelerated as viscosity decreased, up to a certain point. A rise in temperature accelerated penetration, but beyond a fixed point lower temperatures did not result in correspondingly retarded penetration. A correlation was found between age of the insect egg and rate of penetration of an oil. In comparing two types of insect eggs a marked difference was observed in the rate of penetration, owing, no doubt, to the characteristics of the egg itself. (W. C. O'KANE, J. G. CONKLIN)

Nature of the Insect Epicuticle

Since the epicuticle is the uppermost layer of an insect's body, the nature of this ultimate covering is important. Presumably, a contact insecticide to reach maximum efficiency must be able to penetrate this layer.

Studies were carried out intended to shed further light on this problem. Experimental work utilized largely the tomato worm, *Protoparce quinquemaculata,* which, because of its large size, yields conveniently large pieces of integument.

The epicuticle of the tomato worm was found to be insoluble in all of a wide variety of solvents tested. This is in agreement with the work of previous investigators. The epicuticle was found to be extremely resistant to heat, remaining visibly unchanged after heating to 180° Centigrade.

To obtain information on the surface molecular layer, the equilibrium angle of contact of water on the epicuticle was determined. The angle was found to be 104.4 degrees, which is within experimental error of the value found for the contact angle of water on paraffin wax (105.5 degrees). This would seem to indicate that the outward-directed chemical groups on the surface of the epicuticle consist of $-CH_3$ and $-CH_2$ groups only, with no oxygen.

Examination of the exuviae of various insects confirmed the statement that steroles are present in this material. Attempts to separate the epicuticular material (cuticulin) from the material of the underlying layers were not completely successful. (W. C. O'KANE, L. C. GLOVER, J. G. CONKLIN, A. STANDEN)

Technique for Utilization of Houseflies In Studies of Toxicants

The insect toximeter described in Technical Bulletin 76 has been adapted to utilization of adult houseflies in certain appropriate studies of toxicants. Since the toxic substances obtained from pyrethrum flowers and from derris root are growing scarce, and since both of these have been widely used in fly sprays and cattle sprays, intensive study of possible toxicants from the chemical laboratory are important. A modification of the insect toximeter makes it possible to use houseflies. The modification involves the use of spheres made of gauze wire. Adult houseflies are introduced into a sphere which is then hung from a suitable support on the turntable of the toximeter. An atomized spray is directed toward the sphere from two angles while it slowly revolves. The flies are immediately transferred from the sphere to an observation cage where the effects of the sprays can be reported. Since the spheres have been made available in large numbers, exploration of possible toxicants can proceed smoothly and rapidly. (W. C. O'KANE, L. C. GLOVER, J. G. CONKLIN, A. STANDEN)

Sawflies, Gipsy Moths, and Apple Maggots

The year 1941 was notable for the extreme reduction in infestation of the European spruce sawfly. This reduction was so great as to render further extensive field studies with predators inadvisable for the present. At only one point in the state, in the town of Pittsburgh, was there any evidence of visible feeding by the saw fly. This investigation will be resumed as soon as sufficient infestation develops.

During the year a number of collections of gypsy moth caterpillars were made in order to obtain data on the prevalence of the introduced larval parasite *Parasetigena silvestris*, and further collections are planned for the current year.

In the summer of 1940 observations at a number of points in the state indicated that the gypsy moth parasite, *Anastatus disparis*, was rather prevalent, and collections of egg masses were made at a number of points to determine the degree of parasitism. Examination of these eggs revealed that in some localities, particularly in the southern counties, as many as 20 to 30 per cent of the eggs were destroyed by this insect.

Also in 1940, visits were made to a number of localities in the state where *Calasoma sycophanta,* an important predator of the gypsy moth, had been reported in numbers. Observations indicated that this insect was building up in abundance throughout most of the area generally infested by the gypsy moth.

In the fall of 1940 the department cooperated with the Federal Bureau of Entomology and Plant Quarantine in scouting several counties to determine the extent of European corn borer infestation. The results of this survey indicated a decrease in infestation in Hillsboro, Strafford, Merrimack, and Rockingham counties. At the same time, there was a definite trend toward increase in Sullivan and Grafton counties. In general, the borer was less abundant in 1940 than in the previous year, with an average of 51.4 borers per 100 plants in 1939 and 34 per 100 plants in 1940.

Because apple maggot infestations fluctuate with succeeding years this project has been inactive during the period of this report, but the department is continually on the alert for any evidence of new developments. (W. C. O'KANE, J. C. CONKLIN)

NUTRITION — VITAMINS — METABOLISM

Because of the Lend-Lease Act and other events incident to and preceding our country's declaration of war, a national emergency in human nutrition became evident in the latter part of the year 1941. Nation-wide sectional meetings of the Agricultural Experiment Station representatives were arranged to provide an opportunity to discuss and consider plans for participation in a comprehensive study.

The northeastern sectional conference was held in New York City on January 2 and 3, 1942. Within a month members of our home economics and agricultural and biological chemistry departments had organized and sufficiently developed an outline dealing with factors of nutrition related to New Hampshire grown fruits and vegetables to receive authorization from Washington to pursue the plans with federal funds.

Factors Affecting Nutritive Value of New Hampshire Grown Fruits and Vegetables

Under the above title definite investigations have been started particularly in relation to blueberries and squash. Both are well known and important food products grown in New Hampshire about which little information is available concerning their contribution to the newer phases of human nutrition. Preliminary analyses of the ascorbic acid and carotene content of these and some other fruits and vegetables are now in process of analysis. (WILMA D. BREWER, S. R. SHIMER, H. A. DAVIS, T. LEVCOWICH)

Adequacy of Diets of New Hampshire Families

Approximately six hundred completed dietary survey questionnaires have been obtained. These were prepared to investigate the nutritional status and food habits of New Hampshire families during the late winter and early spring months, and also to study the possible relationships be-

tween the adequacy of the family dietary and the income level, the home production of foods, and the location of home (farm, village, city). Tabulations and analysis of the results are now under way. (Alice M. King)

Varieties of Fruits and Vegetables For Home Preservation

Fifteen varieties of fresh strawberries were judged for quality of texture, color, shape, and flavor. Of these, Ambrosia, Narcissa, Dresden, Shelton, Tupper, Pathfinder, and Fairfax rated highest. Strawberry preserves were prepared from eight varieties of strawberries. The following varieties gave good-quality preserves: Dresden, Pathfinder, Ambrosia, and Shelton.

There was little difference in the suitability of either the Yellow Spanish or Gov. Wood varieties of light sweet cherries for home freezing or canning. For freezing, the Montmorency cherry was superior to the Early Richmond. Bing, Schmidt, and Black Tartarian, varieties of the dark, sweet cherry, were all suitable for freezing. In each case the unpitted cherries ranked higher than the pitted.

Among the raspberries tested for freezing, Indian Summer ranked highest in quality. The fruits used in this study were provided by the horticulture department. (Wilma D. Brewer)

Nutrition Studies with Dairy Cattle

The study of the protein and of the energy requirements for growth of dairy heifers includes ten complete balances of the ingo and of the outgo of matter and of energy on animals up to about 33 months of age. A series of basal metabolism experiments on calves from birth up to four months of age, which are now under way, will complete the study of the growth phase of this project.

The result of primary interest at this particular time brought out by these studies relates to possible economies that can be made in feeding. Although the amount of protein actually consumed was from 20 to 30 per cent below the amount which standards in general use provide for, the nitrogen balances showed a retention of this substance indicating protein deposits amounting to over 100 grams per day. This corresponds closely to the actual average daily increase of 1.4 pounds recorded for the period.

In addition to a good quality of early cut hay (native mixed grasses), a simplified concentrate mixture was given. The ingredients used were cornmeal, ground oats, ground barley, and wheat bran, fortified with one part of either linseed meal or cottonseed meal to nine parts of the former. By using the cornmeal, ground oats, and barley in different combinations (under paired feeding conditions) it was found that, as indicated by the nitrogen and energy balances, ground oats and ground barley gave approximately the same results, and both were somewhat superior to cornmeal.

The project is being continued in a revised form to study the protein and the energy requirements for lactation. (E. G. Ritzman, N. F. Colovos)

Studies on Energy Expended by a Horse at Work

These studies have been continued during the year by measuring the effect of speed on the energy expended by the horse. A long series of experiments was carried out with a Morgan mare to determine the comparative amount of energy expended when standing quietly, walking, and trotting at different speeds with and without carrying a rider.

The results showed that quietly standing required 9 calories per minute; walking at a moderate speed increased it to 26 calories; at a slow trot (1 mile in 8 minutes) raised it to about 50 calories, and increasing the speed still further (1 mile in 4 minutes) brought it up to 75 calories, or over eight times the standing value. The energy cost of carrying a rider (weighing with saddle, etc., 175 pounds) at a walk increased 30 per cent, but at a trotting speed of 5.4 minutes per mile the cost of carrying this weight increased it 75 to 80 per cent over trotting without load.

Likewise, in the case of larger draft horses pulling loads, the energy cost increased per pound pull from 14.5 calories at 160 pounds resistance to 25.0 calories at 250 pounds resistance, the speed of walk being the same. Based on a continuous effort of one hour, the energy expended to pull at 160 pounds resistance was 2,300 calories, but at 250 pounds resistance it was 6,260 calories, or nearly trebled.

The result of primary interest in the comparative amount of energy spent at different degrees of exertion is observed in the tremendous increase in the energy cost of work when the rate or speed at which the work done is increased.

Physical effort is expensive in energy cost, and any economies that may be necessary must be obtained by management, the prevention of waste by unnecessary effort, and possibly by some substitutions in the character of the feed rather than in the amount.

Fig. 5. Peacetime Study of Energy Expended by Horse at Work

The maintenance of a team of two horses costs 33,610 calories per day, and they spend 11,250 calories per hour to pull the plow. On the basis of six hours steady pulling (allowing time for rest) per day this would amount to a total of 101,110 calories, which is equal to the available energy contained in a ration (for each horse) consisting of 20 pounds of good Timothy or grass hay plus 25 pounds of corn and 2 pounds of linseed meal, or a ration consisting of 20 pounds of such hay and 30 pounds of oats.

Obviously this is more than a horse weighing 1,500 pounds can consume without danger of foundering, but if fed within safe limits horses spend more than they consume and consequently lose flesh.

There are only three ways to prevent this loss of flesh.

1. Work fewer hours and rest between.
2. Cut down width or depth of furrow.
3. Use a three-horse hitch.

(E. G. RITZMAN, N. F. COLOVOS)

Gas Masks

A study was also made of the efficiency of an army gas mask for horses. A mask for this purpose was supplied by the Chemical Warfare Service of the Army which was deeply interested in the results. (E. G. RITZMAN, N. F. COLOVOS, A. LITTLEHALE)

POULTRY

Protein Requirements of Chickens

The objectives of this study were (1) to determine the relative efficiency of utilization of the two animal protein concentrates, dried skimmilk and vacuum-processed fish meal, when used as the sole animal protein source at two different levels in chick rations, (2) their influence on the pH of the intestinal tract, and (3) their effect on enzyme action in the gizzard of the bird.

Two hundred and forty day-old New Hampshire chicks were divided into four groups of sixty chicks each and fed all mash rations similar to those previously reported in Station Bulletin 312 and 335. Group I was fed the 15 per cent dried skimmilk diet; Group II, the 19 per cent dried skimmilk diet; Group III, 15 per cent vacuum-processed fish meal, and Group IV, 19 per cent vacuum-processed fish meal.

At eight and ten weeks of age, respectively, a lot of five females of approximately the same body weight were removed from each group in the growing batteries into individual experimental cages and continued for a period of one week for nitrogen determination studies. During this period individual daily feed and body weight records were maintained. The feed was similar to that already mentioned. During the week's period of individual study a representative accumulated sample of feces from each bird was taken and was dried and analyzed for various nitrogenous excretory compounds. At the termination of this weekly test period all birds were killed, the digestive and intestinal tracts removed by

sections, and a corresponding pH determination made for each section. The gizzard contents were removed and preserved for later enzymatic studies.

Tabulations have been made showing (1) the composition of the four diets as used in this experimental procedure, (2) the average feed consumption in pounds per chick for all groups by specified periods as maintained in growing batteries, and (3) the pounds of feed required to produce one pound of gain. It is interesting to note that approximately the same quantities of feed were consumed by each group at the two similar protein per cent levels, but the relation of feed consumed to the average body weight attained at twelve weeks of age indicates that feed efficiency was quite variable.

The 19 per cent protein groups were more efficient in the utilization of feed, and at both the 15 and 19 per cent levels the fish meal diet was used more efficiently than the dried skimmilk diet. A difference of 0.3 pound for the lower protein content group in favor of the fish meal fed birds was noted, whereas with the higher protein content mash this difference increased to 0.5 pound of feed.

The mortality during the 12-week period was in order of groups: 5, 4, 6, and 3 chicks, respectively. In no case was the loss excessive. Pneumonia was the chief cause of mortality. (A. E. TEPPER, T. B. CHARLES, S. R. SHIMER, H. A. DAVIS)

Cause and Prevention of Gizzard Lesions in Chickens

Last year the progeny of certain families of chicks showed a lower incidence of gizzard erosions than other families. On the basis of this four pens of hens were made up, the first, from a family with extremely low incidence; the second, a family of high incidence; the third, an intermediate group; and the fourth, a mixed group of high and low birds. Eggs were obtained from these four pens of birds over a period of 16 weeks. The chicks hatched from these eggs were killed after 24 hours and the gizzard lesions examined and scored. Birds belonging to the low group remained low, and those in the high group remained high. However, the difference between the two groups was not nearly so marked as it was the previous year. Progeny from these two groups are being raised so this test can be repeated another year.

With 210 pedigree hatching eggs from identical dams divided into two equal lots and placed in similar incubators, some temperature studies have been conducted. After 450 hours of normal heat in accordance with the incubator manufacturer's recommendation, one lot of eggs was subjected to a temperature 5°F. below normal for a period of 12 hours and then returned to normal until hatching time. All chicks hatched were killed and examined. The reasoning to be checked is whether by slowing up the stage of yolk inclusion in the body cavity, a slowing of the rate of blood-pressure increase might also result and thus reduce gizzard lesion severity.

Various mechanical operations affecting the yolk in eggs harboring well-developed embryos were performed. With all care the resulting

mortality was too high to allow for significant comparisons. However, the four or five chicks which survived the embryonic separation of the yolk all showed presence of lesions.

Comparative work with various dietary control measures has been in progress for a year. The two specified rations commonly termed corn base and oat base diets were fed to two groups of 30 mature breeding females for an adjustment period of eight weeks, after which sixteen consecutive weekly hatches were made. Upon the completion of each hatch, all pedigreed chicks were killed and their gizzards removed for study of the presence and severity of lesions prevailing.

Detailed reports are available covering each of these hatches, together with a line graph showing the trend of average gizzard lesions severity experienced in the two lots of chicks as produced. Throughout this sixteen-week period the oat base diet was somewhat more protective against gizzard lesion severity than was the corn base diet. Wide variations between hatches were noted, but in every case the chicks hatched from those birds fed the oat base diet averaged to show a less severe lesion. However, it remains doubtful if there is any significant difference between the two lots.

Tests were carried out supplementing various rations with 0.5 per cent hesperidin, a flavanone glucoside. This supplementary product, as a member of the citrin or vitamin P group of factors, was used to determine its possible action in strengthening gizzard capillaries and thus tends to prevent the occurrence of hemorrhage lesions in day-old chicks. The results indicated little or no effect in reducing the incidence or severity of gizzard lesions. In place of hesperidin a 3 per cent dried cereal grass was used. Again, there was no appreciable effect on the subsequent gizzard score. (A. E. TEPPER, E. F. WALLER, C. W. HESS, T. B. CHARLES)

The Etiology, Pathology, and Prevention Of Contagious Indigestion

Bluecomb disease as we encounter it is usually accompanied by one of the three following histories: (1) affects young birds of both sexes while they are still on the range, (2) affects only pullets in production soon after they are confined to the laying house, (3) affects mature hens throughout the entire laying period. In this third group only an occasional bird is affected every few days, and the disease does not reach epidemic proportions. There has been some disagreement among poultry pathologists as to whether the symptoms and lesions encountered in these three conditions were all various manifestations of one disease or whether they were different diseases.

In our investigations we have worked primarily with the highly acute fatal type affecting pullets soon after housing, and the results reported here are those obtained with a virus isolated from such cases. On September 10, 1941, a poultryman submitted 3 dead and 2 sick hens to the laboratory. Upon necropsy the dead birds all presented lesions grossly typical of Bluecomb disease. Blood from the sickest of the two live birds was drawn into a sodium citrate solution and was then injected into incubating eggs. The hen was destroyed, necropsied, and tissues taken

for sectioning. From the inoculated eggs a filterable agent was attained, which when injected into susceptible chickens produced symptoms and lesions similar to those of spontaneous cases but it did not produce the death of the bird.

Eight- or nine-day-old embryos appear to be the most susceptible. When the virus is introduced into the artificial air cell on the side of the egg, an opaque thickened area is usually observed at the point where the inoculum was deposited. The center of this lesion may or may not be necrotic and depressed. From the margin of the lesion there are radiating opaque cordlike thickenings extending along the blood vessels of the chorio-allantoic membrane. This produces a lesion that may be best described as "Medusa head like". The membranes may also be markedly thickened with edema. The other type of colony observed is circular lesionlike as if the growth had taken place around the border of the drop of inoculum. This type may also have its radiating processes and be accompanied by edema of the membrane. The lesions reach their maximum size after 72 hours. At 96 hours the embryos are either dead or the lesions tend to localize and the edema disappears. The live embryo at 72 hours shows some retardation and often hemorrhages into the skin or into the peritoneal cavity. The yolk material present is thinned and watery. The affected chorio-allantoic membrane carries the greatest concentration of the infectious agent, but it is also present in the embryo and the embryonic fluid.

When the infected embryonic tissues are fed or injected into susceptible chickens we observe a characteristic rise in the leucocyte count beginning as early as 24 hours after inoculation and reaching its peak at about the ninety-sixth hour, then rapidly returning to normal. This leucocytosis is accompanied by a certain amount of depression, anorexia, cyanosis, and edema. Diarrhea does not result, but the amount of urates and mucus in the feces increases. If the birds are destroyed and necropsied at the time when the leucocyte count is at its height we may observe the following: subcutaneous edema, generalized icterus, hemorrhages into the skeletal muscles, subperiosteal hemorrhages of the flat bones, subserus hemorrhage on the duodenum, petechation of heart and lungs, swollen congested liver and kidneys, and acute catarrhal or hemorrhagic duodenitis. Miscroscopic lesions are similar to those observed in spontaneous outbreaks, varying only in degree of severity and extent. The intestinal contents of inoculated birds are capable of reproducing these lesions if fed to another susceptible bird. Any combination of or all of these lesions may be observed in a single bird. All aged birds are not equally susceptible. One-day-old chicks so far have been refractory to intravenous, subcutaneous, and intraperitoneal injections of infective material. Ten- to fourteen-week-old birds show the highest incidence of visible symptoms following inoculation, but pullets just coming into production show the most severe symptoms and lesions if affected at all.

It has been found that the sera of birds that have recovered from the inoculation will agglutinate an antigen made by suspending washed autoclaved *S. pullorum* in the embryonic fluid of infected embryos. The agglutinins appear in the blood stream about the tenth day after inocula-

tion. Birds with a strong agglutination reaction in dilutions of 1 to 20 or higher do not show the characteristic leucocytosis following inoculation.

When an artificial air cell was made on the side of eggs produced by inoculated hens we were able to isolate the virus from the embryo and embryonic membranes of many of them. The virus was present in 80 per cent of all eggs examined two months after the hens had been inoculated, and in 20 per cent five months after inoculation. We have also been able to isolate the virus from 2 of 24 eggs examined from a flock where the disease was reported to be present.

In all we have been able to isolate this infectious agent from birds originating from four separate poultry farms and from the eggs of a fifth farm. All give the same type of gross lesions in the eggs and in susceptible birds. Serum from a bird injected with any of the strains will agglutinate an antigen made with any of the five strains. Intranasal, intratracheal, and intracutaneous injections have eliminated the possibility of bronchitis, laryngotracheitis and fowl pox. Birds with a positive agglutination titer to this Bluecomb virus are susceptible to larnygotracheitis and fowl pox. (E. F. Waller, A. E. Tepper, R. B. Halpin, H. A. Davis)

Influence of Size of Eggs on Hatchability, Rate of Growth, and Feed Consumption of Crossbred Broiler Chicks

Two pens of approximately 125 New Hampshire females on the University Poultry Farm were mated with mature Barred Plymouth Rock males for the production of crossbred hatching eggs. Starting on October 15, 1941 all eggs laid by these birds were weighed and sorted into groups, weighing, respectively, 20-21, 22-23, 24-25, and 26 ounces and above until a maximum of 360 eggs per group were selected. On October 29 these respective groups of eggs were incubated and the resultant chicks brooded in separate floor pens for a period of twelve weeks.

All chicks were fed the New England College Conference chick starting ration. Starting at eight weeks of age two pounds of cracked yellow corn was fed daily per 100 birds to all groups. Feed consumption, mortality, and growth records were maintained weekly.

The hatchability of these eggs for all groups was very good, ranging from 77.8 to 85.0 per cent of total eggs set. It is to be noted that the 24-25 ounce egg size group showed the highest per cent of hatchability, whereas those eggs 26 ounces or over in weight per dozen gave the lowest percentage hatchability. This same relationship holds true when the ratings are based on per cent hatch of fertile eggs. Here, however, the range is from 82.11 per cent to 92.16 per cent, nearly a ten per cent differential.

Upon the completion of the hatch a random selection of 225 day-old chicks from each group was made. These chicks were placed in similar brood pens 12 feet by 24 feet in size and heated by a continuous hot water system. The birds were maintained in these same pens without culling for a period of twelve weeks.

It was evident that large chicks will ordinarily result from the hatching of large eggs. However, this initial advantage is not necessarily

maintained, for the smaller chicks soon made up the initial difference and by the fourth week all groups averaged to weigh approximately the same. At the end of the twelve-week period of growth those chicks from 24-25 ounce eggs averaged 3.125 pounds whereas those from 26 ounce and over eggs averaged but 2.537 pounds. The group of chicks hatched from 20-21 ounce eggs averaged 2.875 pounds per chick, second in growth rate.

During the ninth week of this test an outbreak of coccidiosis occurred in all pens, but heaviest mortality was experienced in the 26 ounce and over group. This disease may reasonably have caused the poorer growth of this lot of chicks.

An analysis of the average weekly feed consumption per bird for all groups was made together with the calculated feed efficiency factor based on the pounds of feed required to produce one pound of gain in weight. The chicks hatched from eggs weighing 24-25 ounces per dozen were most efficient in feed utilization; chicks hatched from the largest eggs were least efficient in the utilization of feed consumed, requiring 3.9 pounds or 0.4 additional pound of feed per pound gain in weight over that required by the 24-25 ounce egg group.

Most careful records and tabulations indicated that the size of hatching eggs as used in the production of broiler chicks influenced but slightly the efficiency of results subsequently obtained. Probably crossbred broiler chicks hatched from eggs of standard weight per dozen (24 ounces) are to be preferred, but actual differences resulting from the use of small, intermediate, and large hatching eggs are small and inconsistent. (A. E. TEPPER, R. B. HALPIN, T. B. CHARLES)

Poultry Autopsies

Autopsies were made on 2,641 birds comprising 610 cases, consisting chiefly of adult chickens, chicks, adult turkeys, and poults.

Most troublesome diseases of adult fowl were leucosis, bluecomb, chronic coccidiosis, ruptured egg yolk, and roundworms. Chick and growing stock diseases most encountered were omphalitis, acute coccidiosis, chronic coccidiosis, epidemic tremors, gizzard erosion, and losses from pneumonia, chilling, and overheating. Autopsies were made on twenty-one miscellaneous specimens other than poultry. (A. C. CORBETT, F. E. ALLEN, E. F. WALLER)

Pullorum Testing

The pathology laboratory of the poultry department tested 980,872 blood samples from poultry for the State Department of Agriculture. This represents an increase of 149,052 samples, or 19 per cent, over the previous testing season. On first test a total of 106 reactors were found in six flocks. A total of 579 flocks were tested, and all but six of these were free of pullorum disease. However, considering all flocks, the infection was negligible and amounted to only 0.011 per cent of all birds tested, including chickens, turkeys, and any other poultry found on these farms. (A. C. CORBETT, F. E. ALLEN, E. F. WALLER)

Poultry Improvement Under the National Poultry Improvement Plan

New Hampshire is participating under the following breeding phases of the National Poultry Improvement Plan: U. S. Register of Merit; U. S. Record of Performance; U. S. Certified; U. S. Approved.

U. S. Register of Merit: This year nine of the eleven R.O.P. breeders of chickens are taking advantage of this advanced breeding stage that recognizes the families which produce progeny of outstanding performance. Last year only four were participating in this stage of the N.P.I.P.

U. S. Record of Performance: During the year 1940-41 there were thirteen flocks of chickens and turkeys under official R.O.P. supervision. The two flocks of turkeys are not under the supervision of the N.P.I.P. since there are no provisions for turkeys at present. Turkey flocks are supervised according to the rules and standards set up by the N.H.R.O.P. Association.

During 1941-42 there were eleven flocks of chickens in R.O.P. and one flock of turkeys. There are approximately 6,957 chickens and 200 turkeys entered in R.O.P. this year.

The summary for 1941-42 is not available at present since the records are not completed until December 1942.

U. S. Certified: This year (1941-42) there were again seven flocks that met the requirements of a U. S. Certified flock.

U. S. Approved: This stage of the National Poultry Improvement Plan has shown the greatest increase. In 1941-42 there were 171 flocks that were U. S. Approved as compared with 18 flocks in 1940-41 and 8 in 1939-40. Of these 55 flocks were actually handled by the official inspector, while the other 116 flocks were handled by flock selecting agents and the work checked by the inspector.

There were 302,613 birds represented by these 171 flocks, of which 84,986 were actually handled for U. S. Approval. Of the males 17.5 per cent were rejected by the inspector, as compared with 10.9 per cent of the females; or 11.5 per cent of all birds handled were rejected. (C. W. Hess, D. W. Flagg, H. E. Parker)

Litter Moisture

Data have been collected and observations have been made on litter moisture conditions for a period of approximately three years. These observations and data have included poultry pen humidity, temperature and litter moisture content, similar records for litter maintained in a separate "plot" house affected solely by atmospheric conditions, water absorptive capacity and retention values of various litters, rate of moisture increase in litter replacements to poultry pens, egg production, mortality, water consumption and spillage by birds, effect of under floor heat on litter moisture, and sources of litter moisture.

The chief sources of litter moisture are (1) poultry droppings, (2) bird respiration, (3) water spillage by birds and attendants, (4) atmospheric moisture, and (5) snow or rain storms beating into pen.

Evidence is presented to substantiate many of the statements of others as given in the review of literature, and are given in direct statement form.

1. Warming the floor of the poultry pen helps to maintain dry litter.

2. Controlled ventilation alone does not maintain dry litter in an insulated or uninsulated house with sliding front curtains.

3. Uninsulated houses are damper than insulated houses with the same type of litter used.

4. New Hampshires may be expected to consume approximately 22½ gallons of water per bird per year.

5. No specific standard of proper litter conditions can yet be set up.

6. The moisture content of "desirable" poultry pen litters should not exceed 40 per cent.

7. A certain litter treatment called method "C" will assist materially in maintaining good outward appearance of pen litter but is not very helpful in reducing average litter moisture content.

8. The type of litter used appears to have a greater influence on litter moisture values than insulation, ventilation, or area of floor space per bird.

9. Under our experimental conditions there were no measurable differences in the health, condition, or production of birds on "wet" or "dry" litter. It is conceivable, however, that in the presence of certain diseases or epidemics wet litter may seriously interfere with their control.

10. Prevention of spillage of water by the birds about the waterer is desirable. (T. B. CHARLES, A. E. TEPPER, W. T. ACKERMAN, B. J. FRENCH, R. C. DURGIN, R. B. HALPIN)

MISCELLANEOUS

House Plants

The project was started in August 1940. To date rather complete information has been obtained on eleven species of plants tried under home and office conditions. Limited information has been obtained on seven additional species.

Twenty-five plants of each kind are placed in as many homes or offices and left two months or longer. At the end of this period the plants are taken up and their condition correlated with the treatment they have received. This treatment is determined by means of questionnaires filled out with the aid of persons cooperating.

Breeding work is being carried on with several species of plants with the aim of developing new and more interesting house plants.

Material will be ready later this year for the first of a series of house plant publications. (W. D. HOLLEY)

Experiments with Gerbera in the Greenhouse

Four blocks of 30 plants each were set out in beds in a house kept at 50°F. and another set at 60°F. In each house two blocks were left at

a soil pH of 6.0 and to the others lime was applied alternately to raise the pH to 7.0. Two applications were made, one on September 15 and the other on October 14.

Counts of the production of blooms were taken until February 3. Gathering of data was discontinued at this time because of what appeared to be a toxic condition of the soil. The plants were unhealthy in appearance. Since then the plants have become better established, and it is expected that more data will be secured next winter.

The limited results so far obtained indicate no difference in effects of liming and no lime, but there was considerably greater production of blooms in the warm temperature.

A group of seedling plants were grown in sand culture with nutrient solutions. Half of them were supplied a solution in which the nitrogen was in the form of nitrate and the others were given ammonium ion as a source of nitrogen. In general, the seedlings had less chlorosis in the ammonium series, but what few blooms there were appeared more numerous on the nitrate series. These were transferred to pots of soil on February 28. (STUART DUNN, W. D. HOLLEY)

Sensitive Fern Poisoning in Horses

This project was started to determine if sensitive fern *Onoclea sensibilis* is poisonous to horses.

Suitable stable room was made on campus, and three horses were purchased, one of which proved unsuited to feed. Hay was purchased and transported from the Connecticut Valley, hay which was known to be contaminated with sensitive fern and from a section where apparent poisoning had been frequently reported.

A botanical analysis of the hay was made. The average sensitive fern content of the first lot of hay was 24.25 per cent, of the second lot 2.7 per cent. A chemical analysis of pure specimens of fern showed no cyanogen content.

One horse began to show symptoms of a central nervous disturbance after six weeks. The symptoms were progressive from slight incoordination to prostration with partial blindness and paralysis of the alimentary tract. Necropsy revealed icterus, emaciation, paralysis of stomach and an edema of right cerebral hemisphere. A histopathological examination of various tissues revealed only acute changes of significance in the brain. These were edema, congestion, and degeneration of the neuron cells with an infiltration of glia-cells around the affected neurons. A second brain obtained from a field case revealed the same microscopic lesions distributed over both cerebral hemispheres. A second horse developed a hyperesthesia over the entire body after about ten weeks of feeding. This lasted about four weeks and then gradually subsided. Since this was general over the body and no local lesions developed, it is probable that they were the result of lesions of the central nervous system.

To date, the results have been inconclusive but an attempt will be made to collect and post additional cases from the field for comparison with our results. (F. S. PRINCE, E. F. WALLER, A. R. HODGDON, L. V. TIRRELL, T. G. PHILLIPS)

Sheep Breeding

The sheep breeding experiments which have been in progress for 27 years have been brought to a close.

The results of these experiments have demonstrated beyond doubt that a very high degree of fecundity (percentage of twins), an excellent mutton-type lamb, and fleece characteristics of the first order can be combined in a strain of sheep by selection based on group or family production records of related individuals. Fertility in the flock as a whole has been increased from about 135 per cent in the foundation flock to over 150 per cent for the flock as a whole if first gestations are not included, and in selected groups it has been somewhat higher, about 175 per cent. In view of the well-known vital role that fertility plays in livestock economy this should represent a concrete public benefit. No less important is the improvement effected in the milk yield of ewes by the production of the four-nippled strain as the growth of lambs is directly proportional to milk yield of the mothers. (E. G. RITZMAN, A. D. LITTLEHALE)

Seed Inspection

The regular seed testing work covering germination and purity of commercial farm seeds made for the State Department of Agriculture was conducted as usual. During the year 574 samples of seed were handled in the laboratory. Of this number 416 were collected by the state inspector and are reported in Bulletin 334; the remaining 158 tests were made on samples submitted by individuals for their own personal use. The national "referee" work was done as usual. (BESSIE G. SANBORN)

The Lilac and Its Culture

The lilac planting now consists of 165 specimen plants in the arboretum and 157 seedling plants in the nursery and trial plots. Additional plants of species, varieties, and recently introduced hybrids have been planted in the arboretum. It is the intention to secure a representative of all the botanical species in the collection. Some twenty of the possible 28 have been planted to date. A breeding program of species and interspecies crosses has been initiated. The seedling plants represent specimens being grown under the breeding program. Several cases of induced tetraploidy are apparent in specimens from anatomical leaf analysis among colchicine-treated seedlings. Observations on flowering period and landscape suitability are recorded for all plants in the arboretum. A statewide soil analysis survey of *Syringa vulgaris* clumps is under way. (H. S. CLAPP)

Ornamental Woody Plants

There are 67 genera totaling 243 plants under trial for landscape usefulness, winter-hardiness, and adaptability to New Hampshire conditions. Additions to the plot are received from the U. S. D. A. Bureau of Plant Introduction, collected native materials, seedlings, and cuttings,

collection from ornamental plantings, purchased nursery stock, and gifts. Dual-purpose shrubs, those for ornamental use and for edible fruit production, are being observed from collections of native Beach Plum *(Prunus maritima)* and selected strains of this plum forwarded from the Hillculture Division of the Soil Conservation Service. A native honeysuckle *(Lonicera villosa)* has been introduced to observe its usefulness as a food and ornamental plant. Several specimens which are not winter-hardy to this region have been discarded. (H. S. CLAPP)

Chemically Induced Polyploidy

Methods have been worked out whereby colchicine may be used for the production of polyploids in a number of species. These methods are being used in an attempt to produce useful varieties with several species, particularly cucurbits, lilacs, and members of the genus Rubus. (A. F. YEAGER)

Nuts

Of all nut species native to New Hampshire, the butternut is the hardiest. It is widely adapted as to soil and climatic requirements. Following the butternut contest of 1940, seedlings were grown from nuts judged to have the best eating and cracking quality and transplanted at the horticultural farm. These seedlings are making excellent and uniform growth and are now three to four feet tall.

Chinese chestnuts planted in 1940 are now about five feet tall and blossomed in the spring of 1942 but set no fruit.

Winkler hazelnuts, now three years old, have set a good crop of nuts. Five hybrids between native and European hazels are growing well but are not fruiting this year. Cosford, Medium Long, and Italian red, European varieties, do not respond so well to our climate as do the others. (A. F. YEAGER)

Poison Ivy

Poison ivy control experiments were completed this year using ammonium sulfamate. It was found that applications of three-fourths of a pound per gallon of water sprayed on the plants any time when they were in full leaf gave practically 100 per cent kill. Plots sprayed in 1940 show no life as yet. It has also been found possible to spray poison ivy on the trunks of trees and kill it without injuring the tree, provided the leaves of the tree are not hit. A paper giving the results of this experiment is being published in the *Proceedings of the American Society for Horticultural Science.* (HORTICULTURE DEPARTMENT)

Expenditures for the Year Ending June 30, 1941

	Hatch	Adams	Purnell	Bankhead-Jones	Supplementary*
Personal services	$ 9,420.35	$13,838.87	$50,914.46	$6,757.73	$25,525.12
Supplies and materials	755.28	647.68	2,466.19	368.47	4,714.49
Communication service	498.02	6.35	30.57	8.98	358.92
Travel	795.17	67.33	2,035.39	439.00	950.34
Transportation of things	310.20	54.84	92.09	25.15	122.80
Publications	676.29		289.44	232.04	1,080.94
Heat, light, water, power	700.00		9.10	31.58	127.81
Contingent expenses	5.00	.75	13.78		91.30
Equipment	1,827.22	384.18	1,871.40	494.25	1,798.17
Buildings and land	12.47		2,277.58		60.00
Miscellaneous					311.99
Total	$15,000.00	$15,000.00	$60,000.00	$8,357.20	$35,141.88

*This fund includes monies from the following sources:

State Appropriations	
Bankhead-Jones Offset	$ 8,357.20
Miscellaneous Income	23,350.67
Federal Sales	3,434.01

Expenditures for the Year Ending June 30, 1942

	Hatch	Adams	Purnell	Bankhead-Jones	Supplementary*
Personal services	$10,368.78	$13,159.63	$50,475.84	$6,968.06	$29,692.15
Supplies and materials	605.09	899.31	3,288.81	536.64	5,143.09
Communication service	459.80	14.55	34.27	14.91	248.31
Travel expenses	658.66	127.25	1,154.88	636.49	1,921.28
Transportation of things	335.61	9.72	82.50	18.40	243.89
Publications	361.04		1,470.12	146.63	355.19
Heat, light, water, power	700.00	1.76	2.48		
Contingent expenses	5.00		12.65		120.20
Equipment	1,330.98	738.37	1,527.48	161.63	2,045.54
Buildings and land	175.04	49.41	1,950.97	24.64	934.23
Total	$15,000.00	$15,000.00	$60,000.00	$8,507.40	$40,703.88

*This fund includes monies from the following sources:

State Appropriations	
Bankhead-Jones Offset	$ 8,507.40
State research	2,105.60
Miscellaneous Income	27,805.60
Federal Sales	2,285.28